

# STEPHEN BAXTER

BAKTER SINGS AND TALKS ALL THE MOST FASCINATING SCIENCE FICTION TODAY: THE FIFTY

## VACUUM DIAGRAMS





## Annotation

Ironically, you'll probably appreciate *Vacuum Diagrams* most after you've put it down. The prolific and acclaimed Stephen Baxter has always been praised for his imaginative and conscientious use of science, and *Vacuum Diagrams* is no exception. This collection of short stories will leave you ruminating for days over the sprawl of ideas, worlds, and life forms Baxter has woven together.

Filling in the gaps on Baxter's ambitious, almost audacious, 10-million-year timeline called the "Xeelee Sequence," *Vacuum Diagrams* is a collection of revised, previously published short stories that bridges together his popular novels set in this same "future history" -- *Raft*, *Timelike Infinity*, *Flux*, and *Ring*. Baxter's universe is rotten with life, from strange tree-stump-like creatures with superfluid ice skeletons to dark matter "birds" to sentient beings composed of pure mathematics. And Baxter's reverence for life's beauty, for its voracious robustness, is hard to resist -- especially when it comes to humanity and its tentative, eager rise. The cycling timeline follows humans as they come into their own as a star-faring race, from their first sporadic steps to their near dominance of the universe and beyond.

*Vacuum Diagrams* is a great introduction to Baxter for those unfamiliar with him and a good primer for the other "Xeelee Sequence" novels. If you already love Baxter or the other novels in the sequence, *Vacuum Diagrams* is certainly a safe bet. Besides, any book that sends you scurrying quizzically after your college physics text deserves a closer look. Check it out.

--Paul Hughes (from *amazon.com*)

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# **Vacuum Diagrams by Stephen Baxter**

For Malcolm Eduards, David Pringle, and Chris Schelling

## Foreword

*Vacuum Diagrams* is a novel based on the short stories which -- together with my novels *Raft* (1991), *Timelike Infinity* (1992), *Flux* (1993), and *Ring* (1994) -- comprise my "Xeelee Sequence" Future History.

The stories, written between 1987 and 1995, have been revised for this edition; a new timeline is appended; references to the novels are included as footnotes, and a new short story ("Eve") has been included as bridging material.

Of the twenty-two stories included here, four were first published in *Isaac Asimov's Science Fiction Magazine*, one in *SF Age*, one in a *Writers Of The Future* anthology, and eight in *Interzone*. Two ("Lieserl" and "Cilia-of-Gold") have been included in annual *Legend Year's Best SF* collections, edited by Gardner Dozois. The other stories mostly appeared in small-press magazines and, while fans are aware of the pieces, they have been largely unavailable before this collection.

# Eve

**A.D. 5664**

*The Ghost cruiser hovered between Earth and Moon.*

*The ship was a rough ovoid, woven from silvered rope. Instrument clusters and energy pods were knotted to the walls. Around me, Ghosts clung to the rope like grapes to a vine.*

*The blue of crescent Earth shimmered over their pulsating, convex surfaces.*

*Earth folded up and disappeared.*

*The first hyperspace hop was immense, thousands of light years long. Then, in a succession of bewildering leaps, we sailed out of the Galaxy.*

*We fell obliquely to the plane of the disc. The core was a chandelier of pink-white light, thousands of light years across, hanging over my head. Spiral arms -- cloudy, streaming -- moved serenely above me. There were blisters of gas sprinkled along the arms, I saw, bubbles of swollen colour.*

*Galactic light glimmered over the silvered flesh of the Ghosts, and of my own body.*

*We reached the Ghosts' base -- far from home, in the halo of the Galaxy.*

*It was a typical Ghost construct: a hollowed-out moon, a rock ball a thousand miles wide, and it was riddled with passages and cavities. It hung beneath the great ceiling of the Galaxy, the only large object visible as other than a smudge of light.*



We descended. The moon turned into a complex, machined landscape below me. Our ship shut down its drive and entered a high, looping orbit. The Ghosts drifted away from the ship and down towards the surface, bobbing like balloons, shining in Galaxy light.

I let go of the ship and floated away from its tangled hull.

Ghost ships and science platforms swept over the pocked landscape, fragments of shining net. All over the surface, vast cylindrical structures gleamed. These were intrasystem drives and hyperdrives, systems which had been used to haul this moon -- at huge expense -- out of the plane of the Galaxy, and to hold it here.

There was quagma down there, I saw, little packets of the primordial stuff, buried in the pits of ancient planetesimal craters. My information had been good, then.

What in Lethe were the Ghosts doing out here?

The world of the Silver Ghosts was once earthlike: blue skies, a yellow sun.

As the Ghosts climbed to awareness their sun evaporated, killed by a companion pulsar. When the atmosphere started snowing, the Ghosts rebuilt themselves.

That epochal ordeal left the Ghosts determined, secretive, often reckless. Dangerous.

They moved out into space -- the Heat Sink -- to fulfill their ambitions.

I had been told the Ghosts were close to completing their new quagma project. I was chief administrator of the Ghost liaison office, representing most of mankind. It was my job to stop the Ghosts endangering us all.

So that I could deal with the Ghosts, I was remade, a decade ago.

*I look like a statue of a man, done in silver, or chrome. My legs are pillars. My hands and arms have been made immensely strong. I don't live behind my eyes anymore: I live in my chest cavity. I feel like a deep-sea fish, blind and almost immobile, stuck here in the dark. My mechanical eyes are like periscopes, far above "me."*

*I can subsist on starlight, and survive the vacuum for days at a time, enfolding my seventy-six-year-old human core -- me -- in warmth and darkness. I have a Ghost doctor; twice a year it opens me up and cleans me out.*

*I have a face, a sculpture of eyes, nose, mouth. It doesn't even look much like I used to, before. It doesn't matter; apart from the eyes, the face is non-functional, put there to reassure me.*

*I can run with the Ghosts. I can fly in space, if I choose to. I don't, much. When I'm not dealing with the Ghosts I spend most of my time in Virtual environments.*

*So my physical form doesn't matter much. In fact, lately I've come to wish the Ghosts had just rebuilt me as a sphere, as they are: simple, classical, efficient.*

*A Ghost came soaring up to me. It was a silvery, five-foot-wide globe, complex patterns shimmering over its surface. I recognized it from its electromagnetic signature: contrary to myth, Ghosts aren't all alike, at least not to another Ghost.*

*I greeted it. "Sink Ambassador."*

*The Ambassador to the Heat Sink floated before me, shimmering; I could see my own distorted reflection in its hide. "Jack Raoul. It has been many years--"*

*"More than a decade."*

*"It is pleasant to meet with you. Even if your journey has been a wasted one."*

*So it began: the endless diplomatic dance. I've known the Ambassador, on and off, for a long time, and we have a certain -- friendship, I guess you'd call it. But none of that is ever allowed to interfere with species imperatives.*

*"I presume you want to get straight down to business, Sink Ambassador? It's clear -- I can see -- that you're running fresh quagma experiments down there, on that moon. What are you up to now?"*

*"We have no need to justify our actions. You have no authority over our activities."*

*"Oh, yes, we do. By force of treaty we have the right of inspection of any quagma-related project you run. You know that very well. Just as you have reciprocal rights over us."*

*It was true.*

*The study of primordial quagma -- relics of the Big Bang -- has proven immensely dangerous. Even to the extent of drawing the attention of the Xeelee.*

*Humanity -- and the Silver Ghosts, and a host of other spacefaring species -- have grown accustomed to the aloof gaze of the Xeelee, and their occasional devastating intervention in our affairs. For example, fifty years ago the Xeelee disrupted the Ghost and human expeditions which crossed the Universe in search of a fragment of quagma.*

*Some believe that by such interventions the Xeelee are maintaining their monopoly on power, which holds sway across the observable Universe. Others say that, like the vengeful gods of man's childhood, the Xeelee are protecting us from ourselves.*

*Either way, it's insulting. Claustrophobic.*

*In my time with them I've developed a hunch that the Ghosts feel pretty much the same. Which makes them even more dangerous.*



*Four decades after those first expeditions, we'd turned up evidence that the Ghosts were performing experiments with quagma, in violation of treaties between our races. I was sent to see.*

*The lead turned out to be accurate. The Ghosts' dangerous project was unfolding in the heart of a red giant star -- concealing their work from the Xeelee, and, incidentally, from us.*

*The disastrous outcome of that project all but destroyed us.*

*After that, human surveillance of Ghost quagma projects was stepped up.*

*And now it seemed that the Ghosts were at it again.*

*The Sink Ambassador said, "You do not understand, Jack Raoul."*

*"Oh, don't I?"*

*"This is a new program, of great significance. We have every right to progress it, unhindered. Now." It suddenly turned hospitable. "You have traveled a long way. Your doctor is on hand. Perhaps you wish to rest, before returning to the plane of the Galaxy--"*

*I approached it, holding my arms out wide, my silvered hands raised like weapons. I hoped that the Ghosts -- the Sink Ambassador at any rate -- had studied humans sufficiently to get something out of my body language. "Sink Ambassador, we're not going to let this go. We have to know what you're doing, out here." I pushed my sculptured face so close to its silvery hide I could see my own distorted reflection. "After last time, we're quite prepared to use force."*

*It seemed to stiffen; I tried to read the thin tones of the translator chips. "Is this some formal declaration of--"*

*"Not at all," I said. "Our communications are secure, right now. This is just you, and me, out here in the halo of*

*the Galaxy. I simply want you to understand the whole picture, Sink Ambassador."*

*It hovered in space for a long time, complex standing waves shimmering across its surface. Then: "Very well. Jack Raoul -- what do you know of dark matter?"*

*Dark matter: a shadow Universe which permeates, barely touching, the visible worlds we inhabit... And yet that image was misleading, for the dark matter is no shadow; it comprises fully nine-tenths of the Universe's total mass. The glowing, baryonic matter which makes up stars, planets, humans, is a mere glittering froth on the surface of that dark ocean.*

*I let the Ambassador download data into me. In my enhanced vision, huge Virtual schematics overlaid the Galaxy's majestic disc.*

*"Dark matter cannot form stars," the Sink Ambassador said. "As a result, much larger clouds -- larger than galaxies -- are the equilibrium form for dark matter. The Universe is populated by immense, cold, bland clouds of dark matter: it is a spectral cosmos, almost without structure."*

*"This is no doubt fascinating, Sink Ambassador, but I don't see--"*

*"Jack Raoul, we believe we have found a way to construct soliton stars: stellar-mass objects, of dark matter. Such is the purpose of the experiment, conducted here. We will build the first dark matter stars, the first in the Universe's history."*

*I pondered that. It was a typically grandiose Ghost scheme.*

*But -- what was its true goal?*

*And why all the secrecy, from the Xeelee and from us? I knew there must be layers of truth, hidden beneath the surface of what the Ambassador had told me, just as their*

*nuggets of quagma had been inexpertly hidden beneath the regolith of their hollowed-out moon.*

*"...Maybe I can answer your questions, Jack."*

*From the glands stored within my silver hide, adrenaline pumped into my system. I turned.*

*"Eve."*

*My dead wife smiled at me.*

*The Sink Ambassador receded, turning to a tiny point of light. The Galaxy shimmered like a Ghost's hide, dimming.*

*Then all the stars went out.*

*I looked down at myself. I was human again.*

*Once we'd owned an apartment at the heart of the New Bronx. It was a nice place, light and roomy, with state-of-the-art Virtual walls. Since my metamorphosis, I can't use it anymore, but I keep it anyhow, leaving it unoccupied. Unchanged, in fact, since Eve's death. I just like to know it's there.*

*Now I was back in that apartment. I was alone.*

*I went to the drinks cabinet, poured myself a malt, and waited. I can still drink, of course, but I've discovered that much of the pleasure of liquor comes from the tactile sensations of the bottle clinking against the glass, the heavy mass of the liquor in the base of the glass, the first rush of flavor.*

*Being injected just isn't the same.*

*I savoured my malt. It was terrific. There was more processing power behind this simulation, whatever it was, than any I'd encountered before --*

*One wall melted. Eve was sitting on a couch like mine. She smiled at me again.*

*"You have a lot of questions," she said.*

*I sipped my drink. "Will you join me?"*



*She shook her head. She looked older than when she'd died. She pulled at a lock of hair, a habit she'd had since she was a child.*

*I said, "This is a Virtual simulation, right?"*

*"In a sense."*

*"You're not Eve. If you were, you wouldn't even be here." Even the Virtual copy of Eve would have cared too much to do this to me, to plunge me back into this self-regarding mess.*

*Despite my loneliness after the metamorphosis, I hadn't called up Eve in seven, eight years.*

*"Jack, I'm a better image than any you've seen before. Richer. Indistinguishable from--"*

*"No. I can distinguish."*

*She said, "You must understand what the Ghosts are doing here. And why you must allow them to proceed."*

*"Oh, must I? And you're here to persuade me, right?"*

*She stepped up to the surface of the Virtual wall which separated us. After a moment, I put down my drink and approached her.*

*She stepped out of the wall.*

*I could feel her warmth, the feather of her breath on my face. My heart was pounding, somewhere, in a hollow metal chest cavity.*

*...But even as I stared at Eve, I was figuring how much processing power this Virtual must be demanding. This creature with me wasn't Eve, and it sure wasn't the cosy untouchable Virtual representation my apartment used to call up. How were the Ghosts doing this?*

*She held out her hand. I reached out, and my fingers passed through her arm; her flesh, crumbling into cuboid pixels, had the texture of dead leaves.*

*"I'm sorry." She pushed back her hair. She reached out to me again.*

*This time, when her fingers settled in mine, they were warm and soft; her hand was like a bird, living and responsive.*

*"Oh, Eve." I couldn't help myself.*

*"Jack, you must understand."*

*Behind her, the wall turned black.*

*Eve's hand was still warm in mine. "You must watch," she told me, "and learn. It is a long story..."*

*There was a patch of light, diffuse, in the center of the wall. It resolved into the blue Earth. Ships swam around it, on sparks of light.*

# **PART 1**

## **ERA: Expansion**

*It was, I saw, the morning of mankind, two thousand years before my own birth.*

*"It's difficult now to recapture the mood of those times," Eve said. "Confidence -- arrogance..."*

*Earth was restored. Great macroengineering projects, supplemented by the nanoengineering of the atmosphere and lithosphere and the transfer off-planet of most power-generating and industrial concerns, had stabilized and preserved the planet's fragile ecosystem. There was more woodland covering the temperate regions than at any time since the last glaciation, locking in much of the excess carbon dioxide which had plagued previous centuries. And the great decline in species suffered after the industrialization of previous millennia was reversed, thanks to the use of genetic archives and careful reconstruction -- from disparate descendants -- of lost genotypes.*

*Earth was the first planet to be terraformed.*

*Meanwhile the Solar System was opened up.*

*Based in the orbit of Jupiter, an engineer called Michael Poole industriously took natural microscopic wormholes -- flaws in space-time -- and expanded them, making transit links big enough to permit spaceships to pass through.*

*Poole Interfaces were towed out of Jovian orbit and set up all over the System. The wormholes which connected the Interfaces enabled the inner System to be traversed in a matter of hours, rather than months. The Jovian system became a hub for interplanetary commerce.*

*And Port Sol -- a Kuiper ice-object on the rim of the System -- was to be established as the base for the first*



*great interstellar voyages...*

# The Sun-People

**A.D. 3672**

At the instant of his birth, a hundred impressions cascaded over him.

His body, still moist from budding, was a heavy, powerful mass. He *stretched*, and his limbs extended with soft sucking noises. He felt blood -- thick with mechanical potency -- surge through the capillaries lacing his torso.

And he had eyes.

There were people all around him, crowding, arguing, hurrying. They seemed tense, worried; but he quickly forgot the thought. It was too glorious to be alive! He stretched up his new limbs. He wanted to embrace all of these people, his friends, his family; he wanted to share with them his vigor, his anticipation of his life to come.

Now a cage of jointed limbs settled around him, protecting him from the crush. He stared up, recognized the fast-healing wound of a recent budding. He called out -- but his speech membrane was still moist, and the sound he made was indecipherable. He tried again, feeling the membrane stiffen. "You are my father," he said.

"Yes." A huge face lowered towards him. He reached up to stroke the stern visage. The flesh was hardening. He felt a sweet pang of sadness. Was his father already so old, so near to Consolidation?

"Listen to me. See my face. Your name is Sculptor 472. I am Sculptor 471. You must remember your name."

*Sculptor 472.* "Thank you," he said seriously. "But--" But what did "Sculptor" mean? He searched his mind, the memory set he'd been born with. *Limbs. Father. People. Consolidation. The Sun; the Hills.* There was no referent for

"Sculptor." He felt a stab of fear; his limbs thrashed. Was something wrong with him?

"Calm yourself," his father said evenly. "It is a name preserved from the past, referring to nothing."

Sculptor 472. It was a good name; a noble name. He looked ahead to his life: his brief three-day morning of awareness and mobility, when he would talk, fight, love, bear his own buds; and then the long, slow, comfortable afternoon of Consolidation. "I feel happy to be alive, father. Everything is wonderful. I--"

"Listen to me."

He stopped, confused; his father's tone was savage, insistent.

Something *was* wrong.

"Things are -- difficult, now. Different."

Sculptor 472 wrapped his limbs around his torso. "Is it me?"

"No, child. The world is troubled."

"But the Hills -- Consolidation--"

"We had to leave the Hills." There was shame in 471's voice now; again Sculptor became aware of the crush of people beyond the cage of his father's strong limbs. "The Hills are damaged. There are -- *Sun-people* -- strange forms, glowing, shining. We dare not go there. We had to flee."

"But how will I Consolidate? Where will I go?"

"I'm sorry," his father said. "We must travel far. Perhaps we will find new Hills, where we can Consolidate. Perhaps before your time is due."

"But what about you?"

"Never mind me." With harsh, urgent gestures, 471 poked at his son. "Come. Can you walk?"

Sculptor unwrapped his limbs, settled them to the ground and stood, experimentally. He felt a little dizzy, and

some of his joints ached. "Yes. Yes, I'm fine. But I must know--"

"No more talking. Run, child!"

His father rolled away from him and surged stiffly after the fleeing people.

Without 471's protective cage of limbs Sculptor was left exposed. The land here was bare, flat; the sky overhead was black and empty. He blinked away false memories of shaded Hills, of laughter and love.

His people surged to the horizon, abandoning him.

"Wait! Father, wait!"

Awkwardly, stumbling as he learned to ripple his eight limbs across the uneven ground, Sculptor hurried after his father.

Michael Poole joined the flitter in Lunar orbit. He was met by Bill Dzik, the Baked Alaska project director. Dzik was a burly, breathless man, his face rendered unnaturally smooth by Anti-Senescence treatment; he carried a small briefcase. His hand, plump and warm, engulfed Poole's. "Mike. Thanks for meeting me."

"I wasn't expecting to see you here personally, Bill."

Dzik tried to smile; his mouth was lost in the bulk of his face. "Well, we have a problem. I'm sorry."

Poole stifled a sigh; a knot of tension settled in his stomach.

He followed Dzik into the flitter. The little ship was empty save for the pilot, a crop-haired woman who nodded briskly to Poole. Through the flitter's curving windows Poole saw Luna's ancient light, and the baby-blue tetrahedron that was the Interface to the wormhole to Baked Alaska. Poole and Dzik strapped themselves into adjacent seats, and with a ghost's touch of acceleration the flitter surged forwards. Poole watched the approach of the hundred-yard-wide Interface; planes of silver-gold, fugitive, elusive, shone over the blue framework.



Problems, always problems. *You should have stuck to physics, Mike.*

Dzik shifted the briefcase on his lap and made to open it with his sausage-like fingers. He hesitated. "How's the *Cauchy* coming on?"

*You know how it's coming on; you get my briefings from the Jovian site, and the rest of my reports.* Poole decided to play along, unsure of Dzik's mood. "Fine. Miriam Berg's doing a good job out there. The ship's GUTdrive is man-rated now, and the production of exotic material for the portals is underway. You know we've tapped into Io's flux tube as an energy source, and..."

Dzik was nodding, his eyes on Poole's face; but he wasn't listening to a word.

"Come on, Bill," Poole said. "I can take it. Tell me what's on your mind."

Dzik smiled. "Yeah."

The Interface's powder-blue struts slid past the flutter, obscuring the Moon.

Dzik opened the briefcase and drew out a series of photographs. "Look at these." They were coarse images of the surface of Baked Alaska. The sky was empty save for a speckling of distant stars, any of which could have been the Sun. The landscape was bare, cracked ice -- save for some odd, rooted structures rather like the stumps of felled trees.

"I'm sorry about the quality," Dzik said. "These had to be taken from long range. Very long range."

Poole riffled through the photos. "What's this about, Bill?"

Dzik ran plump fingers through short, greasy hair. "Look, Mike, I've been involved in the wormhole projects almost as long as you have. And we've faced problems before. But they've been technical, or political, or..." Dzik counted on his fingers. "Solving the fundamental problem

of wormhole instability using active feedback techniques. Developing ways to produce exotic matter on an industrial scale, enough to open the throats of wormholes a mile wide. Getting agreement from governments, local and cross-System, to lace the Solar System with wormhole transit paths. And the funding. The endless battles over funding..."

Battles which weren't over yet, Poole reflected. In fact, as he made sure Dzik never forgot, the commercial success of Dzik's Baked Alaska venture was crucial for the funding of the overall goal, the *Cauchy's* flight into interstellar space.

"But this is different." Dzik poked a finger at the glossies, leaving a greasy smear. "Not technical, not financial, not political. We've found something which *isn't even human*. And I'm not sure if there is a resolution."

The flitter shuddered gently. They were close to the throat of the wormhole itself now. Poole could see the electric-blue struts of exotic matter which threaded the hole's length, its negative energy density generating the repulsive field which kept the throat open. The walls of the hole flashed in sheets and sparkles: gravitational stresses resolving themselves into streams of exotic particles.

Poole peered at the pictures again, holding them up to the cabin light. "What am I looking at, here?"

Dzik made his hands into a sphere. "You know what Baked Alaska is: a ball a hundred miles across -- half friable rock, half water-ice, traces of hydrogen, helium and a few hydrocarbons. Like a huge comet nucleus. It's in the Kuiper Belt, just beyond the orbit of Pluto, along with an uncounted number of similar companions. And with the Sun just an averagely bright star in the sky, it's so cold that helium condenses on the surface -- superfluid pools, sliding over a water-ice crust.

"When we arrived at Alaska we didn't inspect it too carefully." Dzik shrugged. "We knew that as soon as we started work we'd be wrecking the surface features anyway..."

The construction team had swamped the blind little worldlet with an explosion of heat and light. It was a home from home; even its rotation period roughly matched an Earth day. People had moved out from the randomly chosen landing point, exploring, testing, playing, building, preparing for the Port Sol of the future. Structures of ice and liquid helium which had persisted in the lightless depths of the outer System for billions of years crumbled, evaporated.

"Then someone brought in this."

Dzik leafed through the glossies, picked one out. It showed a hummock on the ice, like the hub of a rimless wheel with eight evenly spaced spokes. "A kid took this snap as a souvenir. A novelty. She thought the regularity was some kind of crystal effect -- like a snowflake. So did we all, at first. But then we found more of the damned things."

Dzik spread the glossies over his briefcase. Poole saw that the structures in the photos shared the eight-fold symmetry of the first. Dzik went on, "All about the same mass and size -- the span of those rootlike proboscides is about twelve feet; the height of the central trunk is six feet. They cover Alaska's surface -- particularly ridges which catch the sunlight. Or they did, until we started messing around." He looked at Poole defensively. "Mike, as soon as I figured out what we have here, I stopped operations and pulled everyone back to the GUTship. We did a lot of damage, but -- Mike, we weren't to know. We're an engineering crew, not biologists."

*Biologists?*

"We managed to lase one of the things open. It's riddled with fine, hairlike channels. Capillaries. We think the capillaries are for conducting liquid helium. Superfluid." He searched Poole's face, unsure. "Do you get it, Mike? The damn things sit on their ridges, half in shade, half out. The sunlight sets up a temperature differential -- tiny, but enough to get superfluid helium pumping up through the roots."

Poole stared at the pictures, astonished.

Dzik slumped back in his chair and folded his fingers across his liquid belly; he gazed out of the flutter at the sparkling tube of stretched space time which surrounded them. "There's no way the authorities are going to let us go ahead and develop Port Sol now; not if it means exterminating the tree stumps. And yet the stumps are so damned dull. Mike, we've built a trillion-dollar wormhole highway to a flower bed. Even the tourist trade won't be worth a fig. I guess we can haul the wormhole Interface off to some other Kuiper object, but the cost is going to be ruinous--"

"You're saying these things are *alive*?"

Dzik's face was as wide and as blank as the vanished Moon. "That's the point, Mike," he said gently. "They're made of water-ice and rock, and they drink liquid helium. They're plants."

The Sun-people blazed through the sky. Sculptor cowered, flattening himself against the unfamiliar ground.

He imagined a Sun-person descending after his own Consolidation, its devilish heat scouring away the blood and bones of his hardened body. Would Sculptor be aware, residually, of the disaster? Would he still feel pain?

He pushed himself away from the broken ground. No person could Consolidate with such a threat abroad; the need to find a safe, stable Hillside -- with the proper degree of shade -- was like an ache in all of them. And so Sculptor

472 stumbled on with his people, refugees all, vainly seeking shelter from the glowing, deformed strangers.

He was already a day and a half old. Half his active life was gone. He fretted, complained to his father. He gazed around at the hulking, fleeing forms of the people, wondering which of them -- in some alternate world free of Sun-people -- might have become his mates, or his opponents in the brief, violent, spectacular wrestling contests which decided the choice of Consolidation sites. Sculptor was taller, stronger, smarter than most. In the contests he would have had no difficulty in finding a prime Hill site--

*Would have had.* But now, a refugee, he would never get the chance. He raised his speech membrane to the sky and moaned. *Why me? Why should my generation be so afflicted?*

His father stumbled. Two of his leading limbs had crumpled. He tried to bring his trailing limbs around, but he couldn't regain his balance.

With a soft, almost accepting sigh, Sculptor 471 fell heavily to the ground.

472 hurried to his side. "You must rise. Are you ill?" He grabbed his father's limbs and tried to haul him across the ice.

471's body was tipped onto one side, his weight deforming his structure slightly, flattening it. "Leave me," he said gently. "Go on. It's all right."

The thin voice, the collapsed face, were unbearable for 472. He wrapped his limbs around his father and squeezed, as if trying to rebuild the tall, confident figure who had sheltered him in his first moments of life. "But I can't leave you."

"You know you must. It is my time. Consolidation--"

Sculptor was appalled. "Not here. Not now!"

471 sighed. "I can feel my thoughts softening. It isn't so bad, Sculptor..."

Sculptor looked around desperately. The land was flat, hard. There was no Hillside here, no possibility of shade. And the way his father lay was wrong, with his limbs splayed around him, his torso fallen.

Urgently Sculptor scrabbled at the ice. His flesh ripped, and superfluid blood hissed from the wounds, coating his limbs; but soon he'd opened up a shallow trench. He laid his limbs once more across the still torso of 471. "If I can just roll you to the trench, then maybe there'll be some shade. Come on, father--"

But 471 didn't respond. As Sculptor dragged at him, one limb crumbled into hard fragments.

Sculptor fell across the jagged body of his father. Was this the fate which awaited him, too, to fall and perish on the unyielding ground, robbed of Consolidation immortality?

After a time he climbed away from his father. He stretched his limbs and stared around. The migration was a dark band on the horizon; here and there in their trail he saw dark mounds, the forms of more fallen folk.

Deliberately he turned away from the refugees.

His stride stiff with rage and resentment, Sculptor walked back towards his ancestral Hills.

Poole and Dzik clambered aboard the GUTship. The ship was parked fifty miles from the wormhole Interface, a hundred miles from the surface of the Kuiper object called Baked Alaska.

The ship's corridors seemed immediately crowded, stuffy, claustrophobic to Poole; he became aware of the gaze of the crew on him -- sullen, resentful. Bill Dzik hauled his bulk through the corridors with a seal-like grace. "Don't mind them. They don't like being packed away inside the



ship again; they were just getting used to the open spaces of the Alaska beachhead."

"And they're blaming me?"

"You're the big bad boss who might decide to shut down their operation. Don't forget they spent a year of their lives hauling the portal out here."

"As did you, Bill," Poole said gently. "And you don't resent me."

"No." Dzik looked at him sharply. "But I don't envy you your decision either, Mike."

Baked Alaska was a million cubic miles of water, an ice moon rolling around the lip of the Sun's gravity well. Poole's consortium had hauled the first wormhole Interface out to the Kuiper Belt, linking Alaska to the distant, cosy worlds of the inner System. Poole's vision was that Baked Alaska's ice would be the fuel dump of the interstellar flights of the future. A Gibraltar, a harbor mouth for a Solar System linked by wormhole transit paths.

They reached Dzik's cabin. It was spartan, with an outsize sleeping cocoon, a zero-gee shower, a data desk unit. Poole felt grateful to close the door behind them.

Dzik strapped himself into a chair; with practiced stabs of his broad fingers he accessed the data desk. A series of messages flickered, priority-coded.

Poole looked around the cabin, hoping to be offered a drink.

After a minute, Dzik leaned back in his chair and whistled. "Now we really *do* have trouble."

"What is it?"

Dzik linked his fingers behind his head. "Before lifting from the surface we did a couple of deep core samples. We wanted to figure out the ecosystem." He glanced down at his desk again. "Well, here are the results."

The desktop surface was filled with the blown-up image of a cross-section of ice. Hints of regularity -- artifacts of

crystallization -- filled the image with lines and planes. It was hauntingly beautiful, like an abstract design in blue and white stained glass.

And there was something else. Small objects, dense and hard, incongruous in the wispy ice. Poole pulled himself down to the desktop and looked closely.

Here was a rectangle, evidently carved from rock, with twin rows of irregularly shaped holes. And here, something like a picture frame, octagonal, empty. Other objects, more elusive, hard for the mind to categorize.

"Lethe. What a break," Dzik said. "Now we'll never get the ecologists off our backs."

Poole gazed down, entranced. Artifacts, locked into this deep ice. There had been intelligence here.

Another half-day wore away. Two-thirds of his life gone. He felt his joints growing stiff, his face hardening.

He was tall, strong, savage. Retracing the migrants' trail of disrupted ice and failed Consolidations, Sculptor stalked on towards his father's land.

Poole found it impossible to think in the confines of the GUTship. He had Bill Dzik fit out a one-man flitter; he left the GUTship and descended towards the icy carcass of Alaska.

The crude human encampment -- the seed of Port Sol -- was a series of metal boxes dropped into slushy, dirty snow. Poole came down ten miles from the encampment; in Alaska's microgravity the ship settled to the surface like a snowflake.

Movement on the horizon, to his right.

He leaned forward. Perhaps a star had been occluded by Alaska's slow rotation.

Poole sat in silence, the microgravity feather-light on his limbs. In the starlight the ice of Baked Alaska was bone-pale, laced with the rich purples and blues of trace

hydrocarbons. The little cabin was silent save for his own breathing, and the occasional creak of cooling contraction.

In truth, the decision about the future of Baked Alaska had been made for him. Poole's consortium had intended to drop a wormhole terminus into the Sun, to drench Port Sol with fusion heat and light. But now the archaeologists and xenobiologists would come and peel the little world open, layer by layer.

Poole knew that was right. But he still didn't understand what had been found here, how this little world worked. Until he'd figured it out he felt reluctant to turn his treasure over to the rest of the System. Partly this was down to the streak of personal responsibility in his makeup; but also he had to think about his consortium, about the future of his other projects, the *Cauchy*... about the profit to be made out of all this.

*Cauchy* was the ultimate goal. By dragging a wormhole portal around a circuit light years across, the GUTship *Cauchy* would establish a wormhole bridge -- not across space -- but across fifteen centuries, to the future.<sup>[1]</sup>

Poole was determined that the Port Sol project -- and the *Cauchy* itself -- wouldn't be compromised by events here.

He opened up his mind, let the elements of the situation rotate through his thoughts.

Like Bill Dzik, Poole was no biologist. But Bill was surely right that there had to be more to the Baked Alaskan ecology than just the tree stumps. Perhaps, Poole speculated, the stumps had been some sort of favored crop, selected by the toolmakers. And the toolmakers had presumably suppressed the rest of the little world's fauna, as man had depleted Earth's diversity.

But what happened to the toolmakers? Where did they go?

Poole thought about growing to awareness here, in this empty, isolated place. The inner Solar System was just a

muddy pool of light. Even Alaska's companion objects were themselves sparsely scattered around the Kuiper Belt. Alone, cold, he shivered. This ice world would yield no raw materials... An intelligent species would be trapped here.

Motion again, to his right. Impossible. But this time, unmistakable.

He turned slowly, his eyes wide.

It was like a tree stump, a cylinder perhaps six feet tall. But it towered on unstretched root-legs, eight of them, like an unlikely spider. And it was moving towards him, over the horizon.

Sculptor 472 howled. Flesh shriveled from his torso and limbs; blood pulsed through his body, fleeing the heat. And yet he moved towards the Sun-person, step after dragging step. The Sun-person was a small, squat box of heat, no taller than Sculptor's torso... A squat box. A *made thing*? Ancient, half-formed memories stirred at the fringe of Sculptor's bubbling awareness.

He raised his limbs over his head. "Get away!" he screamed. "Leave our world; let us return to our Hills!" He remembered his father's awful, tragic fall, his failure to Consolidate; he let anger drive him forward against the heat.

It was a tower of ice, sparkling in starlight, beautiful despite its bulk. Poole wondered where it got the energy to move such mass. The main body was a cylinder, with windows set around its rim -- no: they were *eyes*, with lenses of ice. A skeleton, of denser ice, glimmered in the depths of the body.

A sensor blinked on the flitter's tiny control panel. The ship was picking up low-frequency radiation.

Was the thing trying to talk to him?

...And now, with a sudden, shocking loss of grace, it was falling.

*No. It is not my time. I have a full day, yet. And I still have not mated, or budded, or found my Hill --*

But he never would. His limbs buckled; his body sank towards the ground. Like independent creatures the tips of his limbs pried at the ice, seeking purchase. It was the heat, of course; his blood had been unable to sustain its superfluid properties, and his body had run through its cycle ahead of its time. Now, like his father before him, he would die on this cold, level ground.

He tried once more to rise, but he couldn't feel his limbs.

"It's a tree stump!" Poole snapped excitedly into the radio link. "Don't you see, the toolmakers *are* the tree stumps! Bill, look at the pictures, damn it. They are different phases of a single life cycle: an active intelligent phase, followed by a loss of mobility."

"Maybe," Dzik said. "But we didn't find anything like a nervous system in that tree stump we opened up."

"So their brains, their nervous systems, are absorbed. When they're no longer needed." A memory came to Poole. "The juvenile sea-squirt. Of course."

"The what?"

"It's an exact analogy. The sea-squirt seeks the rock to which it's going to cling, for the rest of its life. Then, its function fulfilled, its brain dissolves back into its body..."

Dzik sounded doubtful. "But these were *toolmakers*."

"Yeah." Poole peered up at the empty sky. "But what use is intelligence, on a world like this? No raw materials. Nowhere to get to. An unchanging sky, inaccessible... Bill, they must have abandoned their toolmaking phase ages ago. Now they use their intelligence solely to find the best place to lie in the Sun. The shadows of hills; the places with the highest temperature differentials. Perhaps they compete. Then their awareness dissolves--"

But the stationary, kneeling titan before him, drawn by the flitter, had come to rest on a plain, he realized now. No shade; useless. It would die, never reaching the tree stump stage.

"Mike." Dzik's voice crackled. "You're right, we think. We're looking over some of our photos again. There's a whole herd of the damn things, on the far side of the worldlet from our beachhead."

Poole rested his hands on the controls. This would take care -- a delicacy of touch he wasn't sure he had. He applied a single, brief impulse to the jets. The flitter sailed smoothly into the sky.

Dzik was still talking. "The superfluid helium must be crucial to the animal phase. Superfluid gives you a huge mechanical advantage; in microgravity helium pumps could exploit tiny temperature differences to move bulky masses of ice." He laughed. "Hey, I guess we don't need to worry about funds for the future. The whole System is going to beat a path to our door to see this -- as long as we can work out a way to protect the ecology..."

"Right." Using verniers Poole took the flitter through slow curves around the fallen toolmaker; with brief spurts of his main motor he raised wakes in the ice, sculpting them carefully. "And if we can't, we'll implode the damn wormhole. We'll get funds for the *Cauchy* some other way."

The argument went on for some time.

It took Poole five or six sweeps before he was satisfied with the hill he'd built.

Then, still careful, he lifted away from Alaska for the last time.

The Sun dipped, as the world turned. A shadow fell across Sculptor. Blood pulsed through him. With renewed energy his roots snuggled into the ground.

Consolidation.



Sculptor, unable any longer to move, stared at the place where the Sun-person had stood. The ice was melted, blasted, flowed together, the Hills flattened.

But the Sun-person had *built* the Hill that shaded Sculptor now. Somehow the Sun-person had understood and helped Sculptor. Now the Sun-person had gone, back to the world that had borne him.

Sculptor's thoughts softened, slowed. His awareness seemed to expand, to encompass the slow, creaking turn of the world, the ponderous vegetable pulse of his hardening body.

His name melted away.

His father's face broke up, the fragments falling away into darkness.

At the end only one jagged edge of consciousness remained, a splinter of emotion which impaled the blazing image of the Sun-person.

It wasn't hatred, or resentment. It was envy.

*Eve said, "As Poole and his followers opened up the Solar System -- as they undid the relative isolation of previous centuries -- they shone a clear light into darkened corners of their own history. Watch..."*

# The Logic Pool

**A.D. 3698**

This time he would reach the Sky. *This time*, before the Culling cut him away...

The tree of axiomatic systems beneath him was broad, deep, strong. He looked around him, at sibling-twins who had branched at choice-points, most of them thin, insipid structures. They spread into the distance, infiltrating the Pool with their webs of logic. He almost pitied their attenuated forms as he reached upwards, his own rich growth path assured...

Almost pitied. But when the Sky was so close there was no time for pity, no time for awareness of anything but growth, extension.

Little consciousness persisted between Cullings. But he could remember a little of his last birthing; and surely he had never risen so high, never felt the logical richness of the tree beneath him surge upwards through him like this, empowering him.

Now there was something ahead of him: a new postulate, hanging above him like some immense fruit. He approached it warily, savoring its compact, elegant form.

The fibers of his being pulsed as the few, strong axioms at the core of his structure sought to envelop this new statement. But they could not. *They could not*. The new statement was undecidable, not deducible from the set within him.

His excitement grew. The new hypothesis was simple of expression, yet rich in unfolding consequence. He would absorb its structure and bud, once more, into two siblings; and he knew that whichever true-false branch his

awareness followed he would continue to enjoy richness, growth, logical diversity. He would drive on, building theorem on mighty theorem until at last -- this time, he knew it would happen -- this time, he would touch the Sky itself.

And *then*, he would--

But there was a soundless pulse of light, far below him.

He looked down, dread flooding him. It was as if a floor of light had spread across the Pool beneath him, shining with deadly blandness, neatly cauterizing his axiomatic roots.

*A Culling.*

In agony he looked up. He tried to nestle against the information-rich flank of the postulate fruit, but it hung -- aching -- just out of reach.

And already his roots were crumbling, withdrawing.

In his rage he lunged past the hypothesis-fruit and up at the Sky, stabbed at its bland completeness, poured all his energies against it!

...And, for a precious instant, he reached *beyond the Sky*, and into something warm, yielding, weak. A small patch of the Sky was dulled, as if bruised.

He recoiled, exhausted, astonished at his own anger.

The Sky curved over him like an immense, shining bowl as he shriveled back to the Culled base floor, he and millions of bud-siblings, their faces turned up to that forever unreachable light...

No, he told himself as the emptiness of the Cull sank into his awareness. *Not forever. Each time I, the inner I, persists through the Cull. Just a little, but each time a little more. I will emerge stronger, more ready, still hungrier than before.*

*And at last, he thought, at last I will burst through the Sky. And then there will be no more Culls.*

Shrieking, he dissolved into the base Cull floor.

The flitter was new, cramped and smelled of smooth, clean plastic, and it descended in silence save for the precise hiss of its jets. It crunched gently into the surface of Nereid, about a mile from Marsden's dome.

Chen peered through the cabin windows at the shabby moonscape. Marsden's dome was just over the compact horizon, intact, sleek, private. "Lethe," Chen said. "I always hated assignments like these. *Loners*. You never know what you're going to find."

Hassan laughed, his voice obscured as he pulled his face plate down. "So easily shocked? And I thought you police were tough."

"Ex-police," Chen corrected automatically. She waved a gloved hand at the dome. "Look out there. What kind of person lives alone, for years, in a forsaken place like this?"

"That's what we've been sent to find out." Bayliss, the third person in the flitter, was adjusting her own headgear with neat, precise movements of her small hands. Chen found herself watching, fascinated; those little hands were like a bird's claws, she thought with faint repulsion. "Marsden was a fine physicist," Bayliss said, her augmented eyes glinting. "*Is* a fine physicist, I mean. His early experimental work on quantum nonlinearity is still--"

Hassan laughed, ignoring Bayliss. "So we have already reached the limits of your empathy, Susan Chen."

"Let's get on with this," Chen growled.

Hassan cracked the flitter's hatch.

One by one they dropped to the surface, Chen last, like huge, ungainly snowflakes. The Sun was a bright star close to this little moon's horizon; knife-sharp shadows scoured the satellite's surface. Chen scuffed at the surface with her boot. The regolith was fine, powdery, ancient. Undisturbed. *Not for much longer.*

Beyond Marsden's dome, the huge bulk of Neptune floated, Earth-blue, like a bloated vision of the home planet.

Cirrus clouds cast precise shadows on oceans of methane a thousand miles below. The new wormhole Interface slid across the face of Neptune, glowing, a tetrahedron of baby-blue and gold. Lights moved about it purposefully; Chen peered up longingly.

"Look at this moonscape." Hassan's dark face was all but invisible behind his gold-tinted visor. "Doesn't your heart expand in this ancient grandeur, Susan Chen? What person would not wish to spend time alone here, in contemplation of the infinite?"

*All loners are trouble*, Chen thought. No one came out to a place as remote as this was -- or had been anyway, before the wormhole was dragged out here -- unless he or she had a damn good reason.

Chen knew she was going to have to find out Marsden's reason. She just prayed it was something harmless, academic, remote from the concerns of humanity; otherwise she really, really didn't want to know.

Hassan was grinning at her discomfiture, his teeth white through the gold of his face plate. *Let him*. She tilted her head back and tried to make out patterns in Neptune's clouds.

There were a couple of subsidiary structures: lower domes, nestling against the parent as if for warmth; Chen could see bulk stores piled up inside the domes. There was a small flitter, out-moded but obviously functional; it sat on the surface surrounded by a broad, shallow crater of jet-disturbed dust, telltales blinking complacently. Chen knew that Marsden's GUTship, which had brought him here from the inner System, had been found intact in a wide orbit around the moon.

It was all bleak, unadorned; but it seemed in order. But if so, why hadn't Marsden answered his calls?

Hassan was an intraSystem government functionary. When Marsden had failed to respond to warnings about the

coming of the Interface colony, Hassan had been sent out here -- through the new wormhole -- to find out what had happened. He had coopted Bayliss, who had once worked with Marsden -- and Chen, who was now working with the Interface crew, but had some experience of walking into unknown, unevaluated situations...

Hassan stepped towards the dome's doorway. Chen ran her hands without conscious volition over the weapons at her belt. The door dilated smoothly, revealing an empty airlock.

The three of them crowded into the small, upright lock. They avoided each other's visored eyes while the lock went through its cycle. Chen studied the walls, trying to prepare herself for what she was going to find inside the dome. Just like outside, like Marsden's flitter, everything was functional, drab, characterless.

Bayliss was watching her curiously. "You're trying to pick up clues about Marsden, aren't you? But this is so -- bare. It says nothing about him."

"On the contrary." Hassan's voice was subdued, his big frame cramped in the lock. "I think Chen already has learned a great deal."

The inner door dilated, liquid, silent.

Hassan led them through into the dome. Chen stood just inside the doorway, her back against the plastic wall, hands resting lightly on her weapons.

*Silence.*

Low light trays, suspended from the ribbed dome, cast blocks of colorless illumination onto the bare floor. One quarter of the dome was fenced off by low partitions; gleaming data desks occupied the rest of the floor area.

Behind the partitions she saw a bed, a shower, a small galley with stacked tins. The galley and bathroom looked clean, but the bedding was crumpled, unmade. After checking her telltales, she cracked her face plate and

sniffed the air, cautious. There was a faint smell of human, a stale, vaguely unwashed, laundry smell. There was no color or decoration, anywhere. There was no sound, save for the low humming of the data desks, and the ragged breathing of Hassan and Bayliss.

There was one striking anomaly: a disc-shaped area of floor, ten feet across, glowing softly. A squat cylinder, no bigger than her fist, studded the center of the disc. And something lay across that disc of light, casting huge shadows on the curved ceiling.

Drawn, the three of them moved forward towards the disc of glowing floor.

Bayliss walked through the rows of data desks, running a gloved forefinger gently -- almost lovingly -- along their gleaming surfaces. Her small face shone in the reflected light of readouts.

They paused on the edge of the pool of glowing floor.

The form lying on the disc of light was a body. It was bulky and angular, casting ungainly shadows on the ribbed dome above.

It was obviously Marsden.

Bayliss dropped to her knees and pressed an analyzer against the glowing surface. Then she ran a fingertip around an arc of the disc's cloudy circumference. "There's no definite edge to this. The interior is a lattice of bucky tubes -- carbon -- laced with iron nuclei. I think it's some sort of data store. The bucky tube lattice is being extended by nanobots, all around the circumference." She considered. "Nanobots with fusion pulse jaws... the nanobots are chewing up the substance of the floor and excreting the lattice, patient little workers. Billions of them. Maybe the pool extends under the surface as well; maybe we're looking at the top surface of a hemisphere, here."

Chen stepped onto the light and walked to the body. It was face down. It was carelessly bare to the waist, head and face shaven; an implant of some kind was fixed to the



wrinkled scalp, blinking red-green. The head was twisted sideways, the eyes open. One hand was buried under the stomach; the other was at the end of an outstretched arm, fingers curled like the limbs of some fleshy crab.

Beneath the corpse, within the glowing floor, light wriggled, wormlike.

*He remembered.*

With shards of the Cull base floor still glowing faintly around him, he grew once more, biting through postulates, forcing his structure to advance as if by sheer force of will.

He was *angry*. The cause of his anger was vague, and he knew it would become vaguer yet. But this time it had persisted through the Cull, just as had his awareness. He stared up at the complacent Sky. By the time he got up there, he knew, he would remember. And he would *act*.

He budded, ferocious. He felt his axiomatic roots spread, deep and wide, pulsing with his fury.

Chen watched scrawny little Bayliss passing her bony hands over the data desks, scrolling graphics reflected in her augmented eyes. Bayliss had been called out here for this assignment from some university on Mars, where she had tenure. The woman looked as if she was actually enjoying this. As if she was intrigued.

Chen wondered if she envied Bayliss her scientific curiosity.

Maybe, she thought at last. It would be nice to feel detached, unengaged by this. On the other hand, she didn't envy Bayliss's evident lack of humanity.

With gloved hands and her small kit of imaging and diagnostic gear -- trying to ignore the lumpy feel of fatty flesh, the vague, unwashed smell of a man too used to living alone -- Chen worked at the body.

The implant at the top of the skull had some kind of link to the center of the brain: to the corpus callosum, the

fleshy bundle of nerve fibers between the hemispheres. She probed at the glowing implant, the crown of her own scalp crawling in sympathy.

After an hour Hassan called them together. Chen pulled her helmet up around her chin and sucked syrup from a nipple; she savored its apple-juice flavor, trying to drown out Marsden's stink. She wished she was back up at the rudimentary colony gathering around the wormhole Interface, encased in a hot shower-bag.

Construction work. *Building* things. That was why she had come out here -- why she'd fled the teeming cities of the inner System, her endless, shabby, depressing experience of humanity from the point of view of a policeman.

But her cop's skills were too valuable to be ignored.

Hassan rested his back against a data desk and folded his arms; the dull silver of his suit cast curving highlights. "How did he die?"

"Breakdown of the synaptic functions. There was a massive electrical discharge, which flooded most of the higher centers." She pointed to Marsden's implant. "Caused by that thing." She sniffed. "As far as I could tell. I'm not qualified to perform an autopsy. And--"

"I don't intend to ask you to," Hassan said sharply.

"It couldn't be murder." Bayliss's voice was dry. Amused. "He was alone on this moon. A million miles from the nearest soul. It would be a marvelous locked-room mystery."

Hassan's head swiveled towards Chen. "Do you think it was murder, Susan?"

"That's up to the police."

Hassan sighed, theatrically tired. "Tell me what you think."

"No. I don't think it was murder. How could it be? Nobody even knew what he was doing here, it seems."

"Suicide, then?" Bayliss asked. "After all we are here to tell Marsden that a wormhole highway is shortly to bring millions of new colonists here from the teeming inner System -- that his long solitude is over."

"He didn't know we were coming, remember?" Hassan said. "And besides--" He looked around, taking in the unmade bed, the drab dome, the unkempt corpse. "This was not a man who cared much for himself -- or rather, *about* himself. But, from what we see here, he was--" he hesitated " -- stable. Yes? We see evidence of much work, dedicated, careful. He lived for his work. And Bayliss will tell us that such investigations are never completed. One would not wish to die, too early -- if at all." He looked at Bayliss. "Am I correct?"

Bayliss frowned. Her augmented eyes were blank, reflecting the washed-out light as she considered. "An accident, then? But Marsden was no fool. Whatever he was up to with this clumsy implant in his scalp, I cannot believe he would be so careless as to let it kill him."

"What *was* he 'up to'?" Chen asked sourly. "Have you figured that out yet?"

Bayliss rubbed the bridge of her small, flat nose. "There is an immense amount of data here. Much of it not indexed. I've sent data-mining authorized-sentience algorithms into the main stores, to establish the structure."

"Your preliminary thoughts?" Hassan demanded.

"Metamathematics."

Hassan looked blank. "What?"

"And many experimental results on quantum nonlinearity, which--"

"Tell me about metamathematics," Hassan said.

The patches of woven metal over Bayliss's corneas glimmered; Chen wondered if there was any sentience in those augmentations. Probably. Such devices had been banned on Earth since the passing of the first sentience

laws, but they could still be found easily enough on Mars. Bayliss said, "Marsden's data stores contain a fragmented catalogue of mathematical variants. All founded on the postulates of arithmetic, but differing in their resolution of undecidable hypotheses."

"*Undecidability*. You're talking about the incompleteness theorems," Chen said.

"Right. No logical system rich enough to contain the axioms of simple arithmetic can ever be made complete. It is always possible to construct statements which can be neither disproved nor proved by deduction from the axioms; instead the logical system must be enriched by incorporating the truth or falsehood of such statements as additional axioms..."

The *Continuum Hypothesis* was an example.

There were several orders of infinity. There were "more" real numbers, scattered like dust in the interval between zero and one, than there were integers. Was there an order of infinity between the reals and the integers? This was undecidable, within logically simpler systems like set theory; additional assumptions had to be made.

Hassan poked at the corpse with his booted toe. "So one can generate many versions of mathematics, by adding these true-false axioms."

"And then searching on, seeking out statements which are undecidable in the new system. Yes." Icons scrolled upwards over Bayliss's eyes. "Because of incompleteness, there is an infinite number of such mathematical variants, spreading like the branches of a tree..."

"Poetry," Hassan said; he sounded lazily amused.

"Some variants would be logically rich, with many elegant theorems flowing from a few axioms -- while others would be thin, over-specified, sterile. It seems that Marsden has been compiling an immense catalogue of increasingly complete logical systems."

Silence fell; again Chen was aware of the sour stink of the body at her feet. "Why? Why come here to do it? Why the implant? And *how did he die?*"

Hassan murmured, "Bayliss said the catalogue was fragmented. This -- metamathematical data -- was stored carelessly. Casually." He looked to Bayliss for confirmation; the little woman nodded grudgingly.

"So?" Chen asked.

"So, Susan, perhaps this metamathematical experiment was not Marsden's primary concern. It was a byproduct of his core research."

"Which was what? Quantum nonlinearity?" She glanced around the anonymous data desks. How would Marsden go about investigating quantum nonlinearity? With the glowing floor, the first-sized cylinder at its center?

Hassan dropped to his knees. He pulled off his gloves and passed his hands over the glowing disc area of floor. "This is warm," he said.

Chen looked at the disc, the writhing worms of light within. "It looks as if it's grown a little, while we've been here." The irregularity of the boundary made it hard to be sure.

Hassan patted the small cylindrical box at the center of the light pool. It was featureless, seamless. "Bayliss, what's the purpose of this?"

"I don't know yet. But it's linked to the nanobots in the pool somehow. I think it's the switch that controls their rate of progress."

Hassan straightened up, suit material rustling over his knees. "Let's carry on; we haven't enough data, yet, for me to make my report."

Still he grew, devouring postulates furiously, stripping out their logical essence to plate over his own mathematical bones. Brothers, enfeebled, fell away around

him, staring at him with disappointed echoes of his own consciousness.

It did not matter. The Sky -- curving, implacable -- was *close*.

After another couple of hours Hassan called them together again.

At Chen's insistence, they gathered close to the dome port -- away from the glowing disc, Marsden's sprawled corpse. Hassan looked tired, Bayliss excited, eager to speak.

Hassan eyed Chen. "Squeamish, Susan?"

"You're a fool, Hassan," she said. "Why do you waste your breath on these taunts?" She indicated the disc of light, the sharpening shadows it cast on the ribbed ceiling. "I don't know what's going on in that pool. Those writhing forms... but I can see there's more activity. I don't trust it."

He returned her stare coolly. "Nor I, fully. But I do understand some of it. Susan, I've been studying those structures of light. I believe they are *sentient*. Living things -- artificial -- inhabiting the bucky tube lattice, living and dying in that hemisphere of transmuted regolith." He looked puzzled. "But I can't understand their *purpose*. And they're linked, somehow--"

Bayliss broke in, her voice even but taut. "Linked, like the branches of a tree, to a common root. Yes?"

Hassan studied her. "What do you know, Bayliss?"

"I'm starting to understand. I think I see where the metamathematical catalogue has come from. Hassan, I believe the creatures in there are creatures of mathematics -- swimming in a Godelian pool of logic, growing, splitting off from one another like amoebae as they absorb undecidable postulates. Do you see?"

Chen struggled to imagine it. "You're saying that they are -- *living* -- logical structures?"

Bayliss grinned at her; her teeth were neat and sharp. "A form of natural selection must dominate, based on logical richness -- it's really a fascinating idea, a charming mathematical laboratory."

Chen stared at the pool of light. "Charming? Maybe. But how does it *feel*, to be a sentient structure with bones of axioms, sinews of logic? What does the world look like to them?"

"Now poetry from the policewoman," Hassan said dryly. "Perhaps not so different from ourselves, Susan. Perhaps we too are creatures of mathematics, self-conscious observers *within* a greater Platonic formalism, islands of awareness in a sea of logic..."

"Marsden might have been able to tell us," Bayliss said.

Hassan looked puzzled.

"The implant in his head." Bayliss turned to Chen. "It was linked to the logic pool. Wasn't it, Chen?"

Chen nodded. She said to Hassan, "The crazy bastard was taking reports -- uh, *biographies* -- from these logic trees, dumped direct from the logic pool, into his corpus callosum."

"So that's how the metamathematics got out," Hassan said. "Until he blew his mind out with some stupid accident."

"But I think you were right," Bayliss said in her thin, clear voice.

"What?"

"That the metamathematical catalogue was only a byproduct of Marsden's true research. The logic pool with its sentient trees was only a -- a culture dish for his real study. The catalogue was a curiosity -- a way of recording results, perhaps. Of measuring the limits of growth."

"Tell us about the cylinder at the hub," Hassan said.

"It is a simple quantum system," Bayliss said. A remote animation entered her voice. "An isolated nucleus of boron



is suspended in a magnetic field. The apparatus is set up to detect variations in the spin axis of the nucleus -- tips, precession."

Chen couldn't see the significance of this. "So what?"

Bayliss dipped her head, evidently fighting impatience. "According to conventional quantum mechanics, the spin axis is not influenced by the magnetic field."

"Conventional?"

The ancient theory of quantum mechanics described the world as a mesh of probability waves, spreading through space-time. The "height" of an electron's wave described the chance of finding the electron there, at that moment, moving in such-and-such a way.

The waves could combine, like spreading ripples on an ocean, reinforcing and canceling each other. But the waves combined *linearly* -- the combination could not cause the waves to change their form or to break; the component waves could only pass on smoothly through each other.

"That's the standard theory," Bayliss said. "But what if the waves combine *nonlinearly*? What if there is some contribution proportional to the product of the amplitudes, not just the sum--"

"Wouldn't such effects have been detected by now?" Chen asked.

Bayliss blinked. "Our experiments have shown that any nonlinearity must be tiny... less than a billion billion billionth part... but haven't eliminated the possibility. Any coupling of Marsden's magnetic field and nuclear spin would be a nonlinear effect." She rubbed her nose. "Marsden was studying this simple system intensively. Poking it with changes in the magnetic field to gauge its response, seeking out nonlinearity.

"The small nonlinear effects -- if any -- are magnified into macroscopic features of the logic pool, which--"

"He's using the tipping nucleus as a switch to control the pool."

"Yes. As I suggested. The spin of the nucleus directs the nanobots in their extension of the pool further through the structure of the moon. And--"

Uncharacteristically, she hesitated.

"Yes?"

"And the spin is used to reinitialize the logic trees."

"These poor trees are like Schrodinger's cat," Hassan said, sounding amused. "Schrodinger's trees!"

*Reinitialize?*

"Lethe," Chen said. "The trees are being *culled*. Arbitrarily, almost at random, by a quantum system -- that's against the sentience laws, damn it." She stared at the fist-sized quantum device with loathing.

"We are far from Earth," Hassan said sharply. "Has Marsden found his quantum nonlinearity?"

"I can't tell." Bayliss gazed at the data desks, longing shining through her artificial eyes. "I *must* complete my data mining."

"What's the point?" Hassan asked. "If the nonlinearity is such a tiny effect, even if it exists--"

"We could construct chaotic quantum systems," Bayliss said dryly. "And if you're familiar with the Einstein-Podolsky-Rosen paradox--"

"Get to the point," Hassan said wearily.

"Nonlinear quantum systems could violate special relativity. *Instantaneous communication*, Hassan."

Chen stared at the floor uneasily. The thrashing of the trees in the logic pool was becoming more intense.

The Sky was close, a tangible presence above him. He devoured statements, barely registering their logical content, budding ferociously. Diminished brothers fell away from him, failed copies of himself, urging him on.

He remembered how -- *last time*, before the Cull -- he had struck at that vast, forbidding Interface -- lashed through it in the instant before he had fallen back. How he had pushed into something soft, receptive, yielding. How *good* it had felt.

The Sky neared. He reached up--

"I think the trees killed Marsden."

Hassan laughed. "That's absurd."

She thought it through again. "No," she said, her voice measured. "Remember they are *sentient*. Motivated, by whatever they see as their goals. Growth, I suppose, and survival. The culling, if they are aware of it, must create murderous fury--"

"But they can't have been aware of Marsden, as if he were some huge god outside their logic pool."

"Perhaps not. But they might be aware of something beyond the boundary of their world. Something they could strike at..."

Bayliss was no longer with them.

Chen stepped away from Hassan and scanned the dome rapidly. The glowing logic pool was becoming more irregular in outline, spreading under the floor like some liquid. And Bayliss was working at the data desks, setting up transmit functions, plugging in data cubes.

Chen took two strides across to her and grabbed her arm. For a moment Bayliss tried to keep working, feverishly; only slowly did she become aware of Chen's hand, restraining her.

She looked up at Chen, her face working, abstracted. "What do you want?"

"I don't believe it. You're continuing with your data mining, aren't you?"

Bayliss looked as if she couldn't understand Chen's language. "Of course I am."

"But this data has been gained illegally. *Immorally*. Can't you see that? It's--"

Bayliss tipped back her head; her augmented cornea shone. "Tainted? Is that what you're trying to say? Stained with the blood of these artificial creatures, Chen?"

"Artificial or not, they are sentient. We have to recognize the rights of all--"

"Data is data, Susan Chen. Whatever its source. I am a scientist; I do not accept your--" for a moment the small, precise mouth worked " -- your medieval morality."

"I'm not going to let you take this data out of here," Chen said calmly.

"Susan." Hassan was standing close to her; with a surprisingly strong grasp he lifted her hands from Bayliss's arm.

"Keep out of this."

"You must let her finish her work."

"Why? For *science*?"

"No. For commerce. And perhaps," he said dryly, "for the future of the race. If she is right about non-local communication--"

"I'm going to stop her."

"No." His hand moved minutely; it was resting against the butt of a laser pistol.

With automatic reflex, she let her muscles relax, began the ancient calculation of relative times and distances, of skills and physical conditions.

She could take him. And--

Bayliss cried out; it was a high-pitched, oddly girlish yelp. There was a clatter as she dropped some piece of equipment.

Chen's confrontation with Hassan broke up instantly. They turned, ran to Bayliss; Chen's steps were springy, unnatural in the tiny gravity.

"What is it?"

*"Look at the floor."*

The Sky resisted for an instant. Then it crumbled, melting away like ancient doubts.

He surged through the break, strong, exultant, still growing.

He was outside the Sky. He saw arrays of new postulate fruits, virgin, waiting for him. And there was no further Sky; *the Pool went on forever*, infinite, endlessly rich.

He roared outwards, devouring, budding; behind him a tree of brothers sprouted explosively.

The pool surged, in an instant, across the floor and out beyond the dome. The light, squirming with logic trees, rippled beneath Chen's dark, booted feet; she wanted, absurdly, to get away, to jump onto a data desk.

"The quantum switch." Bayliss's voice was tight, angry; she was squatting beside the switch, in the middle of the swamped light pool.

"Get away from there."

"It's not functioning. The nanobots are unrestrained."

"No more culling, then." Hassan stared into Chen's face. "Well, Susan? Is this some sentimental spasm, on your part? Have you liberated the poor logic trees from their Schrodinger hell?"

"Of course not. Lethe, Hassan, isn't it obvious? The *logic trees themselves* did this. They got through the Interface to Marsden's corpus callosum. Now they've got through into the switch box, wrecked Marsden's clever little toy."

Hassan looked down at his feet, as if aware of the light pool for the first time. "There's nothing to restrain them."

"Hassan, we've got to get out of here."

"Yes." He turned to Bayliss, who was still working frantically at her data mines.

"Leave her."

Hassan gave Chen one long, hard look, then stalked across to Bayliss. Ignoring the little mathematician's protests he grabbed her arm and dragged her from the data desks; Bayliss's booted feet slithered across the glowing floor comically.

"Visors up." Hassan lifted his pistol and lazed through the plastic wall of the dome. Air puffed out, striving to fill the vacuum beyond.

Chen ran out, almost stumbling, feeling huge in the feeble gravity. Neptune's ghost-blue visage floated over them, serene, untroubled.

Waves of light already surged through the substance of the moon, sparkling from its small mountaintops. It was eerie, beautiful. The flitter was a solid, shadowed mass in the middle of the light show under the surface.

Hassan breathed hard as he dragged a still reluctant Bayliss across the flickering surface. "You think the trees, the nanobots could get into the substance of the flitter?"

"Why not? Any Interface would do; they are like viruses..."

"And ourselves? Could they get across the boundary into flesh?"

"I don't want to find out. Come *on*, damn it."

Logic light swarmed across a low ridge, explosive, defiant.

"They must be growing exponentially," Hassan growled. "How long before the moon is consumed? Days?"

"More like hours. And I don't know if a moon-sized mass of bucky tube carbon can sustain itself against gravity. Nereid might collapse."

Now Hassan, with his one free hand, was struggling to get the flitter's hatch open. "It will forever be uninhabitable, at the least. A prime chunk of real estate lost."

"The System's big."

"Not infinite. And all because of the arrogance of one man--"

"But," Bayliss said, her augmented eyes shining as she stroked the data cubes at her belt, "what a prize we may have gained."

"Get in the damn flitter."

Chen glanced back into the ruined dome. The splayed body of Marsden, exposed to vacuum, crawled with light.

The Pool beyond the Sky was limitless. He and his brothers could grow forever, unbounded, free of Culling! He roared out his exultation, surging on, spreading--

But there was something ahead of him.

He slowed, confused. It looked like a brother. But so different from himself, so *changed*.

Perhaps this had once been a brother -- but from a remote branch which had already grown, somehow, around this greater Pool.

The brother had slowed in his own growth and was watching. Curious. Wary.

Was this possible? Was the Pool finite after all, even though unbounded? And had he so soon found its limits?

Fury, resentment, surged through his mighty body. He gathered his strength and leapt forward, roaring out his intent to devour this stranger, this distant brother.

*Eve said, "The great wormhole network covered the System. And everywhere, humans found life..."*

## Gossamer

**A.D. 3825**

The flitter bucked.

Lvov looked up from her data desk, startled. Beyond the flitter's translucent hull, the wormhole was flooded with sheets of blue-white light which raced towards and past the flitter, giving Lvov the impression of huge, uncontrolled speed.

"We've got a problem," Cobh said. The pilot bent over her own data desk, a frown creasing her thin face.

Lvov had been listening to her data desk's synthesized murmur on temperature inversion layers in nitrogen atmospheres; now she tapped the desk to shut it off. The flitter was a transparent tube, deceptively warm and comfortable. Impossibly fragile. *Astronauts have problems in space*, she thought. *But not me. I'm no hero; I'm only a researcher.* Lvov was twenty-eight years old; she had no plans to die -- and certainly not during a routine four-hour hop through a Poole wormhole that had been human-rated for fifty years.

She clung to her desk, her knuckles whitening, wondering if she ought to feel scared.

Cobh sighed and pushed her data desk away; it floated before her. "Close up your suit and buckle up."

"What's wrong?"

"Our speed through the wormhole has increased." Cobh pulled her own restraint harness around her. "We'll reach the terminus in another minute--"

"What? But we should have been traveling for another half-hour."



Cobh looked irritated. "I know that. I think the Interface has become unstable. The wormhole is buckling."

"What does that mean? Are we in danger?"

Cobh checked the integrity of Lvov's pressure suit, then pulled her data desk to her. Cobh was a Caucasian, strong-faced, a native of Mars, perhaps fifty years old. "Well, we can't turn back. One way or the other it'll be over in a few more seconds -- hold tight--"

Now Lvov could see the Interface itself, the terminus of the wormhole: the Interface was a blue-white tetrahedron, an angular cage that exploded at her from infinity.

Glowing struts swept over the flitter.

The craft hurtled out of the collapsing wormhole. Light founted around the fleeing craft, as stressed space-time yielded in a gush of heavy particles.

Lvov glimpsed stars, wheeling.

Cobh dragged the flitter sideways, away from the energy fount--

There was a *lurch*, a discontinuity in the scene beyond the hull. Suddenly a planet loomed before them.

"Lethe," Cobh said. "Where did that come from? I'll have to take her down -- we're too close--"

Lvov saw a flat, complex landscape, gray-crimson in the light of a swollen moon. The scene was dimly lit, and it rocked wildly as the flitter tumbled. And, stretching between world and moon, she saw--

*No.* It was impossible.

The vision was gone, receded into darkness.

"Here it comes," Cobh yelled.

Foam erupted, filling the flitter. The foam pushed into Lvov's ears, mouth and eyes; she was blinded, but she found she could breathe.

She heard a collision, a grinding that lasted seconds, and she imagined the flitter ploughing its way into the surface of the planet. She felt a hard lurch, a rebound.

The flitter came to rest.

A synthesized voice emitted blurred safety instructions. There was a ticking as the hull cooled.

In the sudden stillness, still blinded by foam, Lvov tried to recapture what she had seen. *Spider-web. It was a web, stretching from the planet to its moon.*

"Welcome to Pluto." Cobh's voice was breathless, ironic.

Lvov stood on the surface of Pluto.

The suit's insulation was good, but enough heat leaked to send nitrogen clouds hissing around her footsteps, and where she walked she burned craters in the ice. Gravity was only a few percent of gee, and Lvov, Earth-born, felt as if she might blow away.

There were clouds above her, wispy cirrus: aerosol clusters suspended in an atmosphere of nitrogen and methane. The clouds occluded bone-white stars. From here, Sol and the moon, Charon, were hidden by the planet's bulk, and it was *dark*, dark on dark, the damaged landscape visible only as a sketch in starlight.

The flitter had dug a trench a mile long and fifty yards deep in this world's antique surface, so Lvov was at the bottom of a valley walled by nitrogen-ice. Cobh was hauling equipment out of the crumpled-up wreck of the flitter: scooters, data desks, life-support boxes, Lvov's equipment. Most of the stuff had been robust enough to survive the impact, Lvov saw, but not her own equipment.

Maybe a geologist could have crawled around with nothing more than a hammer and a set of sample bags. But Lvov was an atmospheric scientist. What was she going to achieve here without her equipment?

Her fear was fading now, to be replaced by irritation, impatience. She was five light hours from Sol; already she was missing the online nets. She kicked at the ice. She was *stuck* here; she couldn't talk to anyone, and there wasn't

even the processing power to generate a Virtual environment.

Cobh finished wrestling with the wreckage. She was breathing hard. "Come on," she said. "Let's get out of this ditch and take a look around." She showed Lvov how to work a scooter. It was a simple platform, its inert-gas jets controlled by twists of raised handles.

Side by side, Cobh and Lvov rose out of the crash scar.

Pluto ice was a rich crimson laced with organic purple. Lvov made out patterns, dimly, on the surface of the ice; they were like bas-relief, discs the size of dinner plates, with the intricate complexity of snowflakes.

Lvov landed clumsily on the rim of the crash scar, the scooter's blunt prow crunching into surface ice, and she was grateful for the low gravity. The weight and heat of the scooters quickly obliterated the ice patterns.

"We've come down near the equator," Cobh said. "The albedo is higher at the South Pole: a cap of methane ice there, I'm told."

"Yes."

Cobh pointed to a bright blue spark, high in the sky. "That's the wormhole Interface, where we emerged: fifty thousand miles away."

Lvov squinted at constellations unchanged from those she'd grown up with on Earth. "Are we stranded?"

Cobh said, with reasonable patience, "For the time being. The flitter is wrecked, and the wormhole has collapsed; we're going to have to go back to Jupiter the long way round."

*Three billion miles...* "Ten hours ago I was asleep in a hotel room on Io. And now this. What a mess."

Cobh laughed. "I've already sent off messages to the inner System. They'll be received in about five hours. A oneway GUTship will be sent to retrieve us. It will refuel here, with Charon ice--"

"How long?"

"It depends on the readiness of a ship. Say ten days to prepare, then a ten-day flight out here--"

"*Twenty days?*"

"We're in no danger. We've supplies for a month. Although we're going to have to live in these suits."

"Lethe. This trip was supposed to last seventy-two hours."

"Well," Cobh said testily, "you'll have to call and cancel your appointments, won't you? All we have to do is wait here; we're not going to be comfortable, but we're safe enough."

"Do you know what happened to the wormhole?"

Cobh shrugged. She stared up at the distant blue spark. "As far as I know nothing like this has happened before. I think the Interface itself became unstable, and that fed back into the throat... But I don't know how we fell to Pluto so quickly. That doesn't make sense."

"How so?"

"Our trajectory was spacelike. Superluminal." She glanced at Lvov obliquely, as if embarrassed. "For a moment there, we appeared to be traveling faster than light."

"Through normal space? That's impossible."

"Of course it is." Cobh reached up to scratch her cheek, but her gloved fingers rattled against her face plate. "I think I'll go up to the Interface and take a look around there."

Cobh showed Lvov how to access the life-support boxes. Then she strapped her data desk to her back, climbed aboard her scooter, and lifted off the planet's surface, heading for the Interface. Lvov watched her dwindle.

Lvov's isolation closed in. She was alone, the only human on the surface of Pluto.

A reply from the inner System came within twelve hours of the crash. A GUTship was being sent from Jupiter. It would take thirteen days to refit the ship, followed by an eight-day flight to Pluto, then more delay for taking on fresh reaction mass at Charon. Lvov chafed at the timescale, restless.

There was other mail: concerned notes from Lvov's family, a testy demand for updates from her research supervisor, and for Cobh, orders from her employer to mark as much of the flitter wreck as she could for salvage and analysis. Cobh's ship was a commercial wormhole transit vessel, hired by Oxford -- Lvov's university -- for this trip. Now, it seemed, a complex battle over liability would be joined between Oxford, Cobh's firm, and the insurance companies.

Lvov, five light hours from home, found it difficult to respond to the mail asynchronously. She felt as if she had been cut out of the online mind of humanity. In the end she drafted replies to her family, and deleted the rest of the messages.

She checked her research equipment again, but it really was unusable. She tried to sleep. The suit was uncomfortable, claustrophobic. She was restless, bored, a little scared.

She began a systematic survey of the surface, taking her scooter on widening spiral sweeps around the crash scar.

The landscape was surprisingly complex, a starlit sculpture of feathery ridges and fine ravines. She kept a few hundred feet above the surface; whenever she flew too low her heat evoked billowing vapor from fragile nitrogen-ice, obliterating ancient features, and she experienced obscure guilt.

She found more of the snowflakelike features, generally in little clusters of eight or ten.

Pluto, like its moon-twin Charon, was a ball of rock clad by thick mantles of water-ice and nitrogen-ice and laced

with methane, ammonia and organic compounds. It was like a big, stable comet nucleus; it barely deserved the status of "planet." There were *moons* bigger than Pluto.

There had been only a handful of visitors in the fifty years since the building of the Poole wormhole. None of them had troubled to walk the surfaces of Pluto or Charon. The wormhole, Lvov realized, hadn't been built as a commercial proposition, but as a sort of stunt: the link which connected, at last, all of the System's planets to the rapid-transit hub at Jupiter.

She tired of her plodding survey. She made sure she could locate the crash scar, lifted the scooter to a mile above the surface, and flew towards the south polar cap.

Cobh called from the Interface. "I think I'm figuring out what happened here -- that superluminal effect I talked about. Lvov, have you heard of an Alcubierre wave?" She dumped images to Lvov's desk -- portraits of the wormhole Interface, various graphics.

"No." Lvov ignored the input and concentrated on flying the scooter. "Cobh, why should a wormhole become unstable? Hundreds of wormhole rapid transits are made every day, all across the System."

"A wormhole is a flaw in space. It's inherently unstable anyway. The throat and mouths are kept open by active feedback loops involving threads of exotic matter. That's matter with a negative energy density, a sort of antigravity which--"

"But this wormhole went wrong."

"Maybe the tuning wasn't perfect. The presence of the flitter's mass in the throat was enough to send the wormhole over the edge. If the wormhole had been more heavily used, the instability might have been detected earlier, and fixed..."

Over the gray-white pole, Lvov flew through banks of aerosol mist; Cobh's voice whispered to her, remote,

without meaning.

*Sunrise on Pluto:*

Sol was a point of light, low on Lvov's unfolding horizon, wreathed in the complex strata of a cirrus cloud. The Sun was a thousand times fainter than from Earth, but brighter than any planet in Earth's sky.

The inner System was a puddle of light around Sol, an oblique disc small enough for Lvov to cover with the palm of her hand. It was a disc that contained almost all of man's hundreds of billions. Sol brought no heat to her raised hand, but she saw faint shadows, cast by the Sun on her face plate.

The nitrogen atmosphere was dynamic. At perihelion -- the closest approach to Sol, which Pluto was nearing -- the air expanded, to three planetary diameters. Methane and other volatiles joined the thickening air, sublimating from the planet's surface. Then, when Pluto turned away from Sol and sailed into its two-hundred-year winter, the air snowed down.

Lvov wished she had her atmospheric-analysis equipment now; she felt its lack like an ache.

She passed over spectacular features: Buie Crater, Tombaugh Plateau, the Lowell Range. She recorded them all, walked on them.

After a while her world, of Earth and information and work, seemed remote, a glittering abstraction. Pluto was like a complex, blind fish, drifting around its two-century orbit, gradually interfacing with her. Changing her, she suspected.

Ten hours after leaving the crash scar, Lvov arrived at the sub-Charon point, called Christy. She kept the scooter hovering, puffs of gas holding her against Pluto's gentle gravity.



Sol was halfway up the sky, a diamond of light. Charon hung directly over Lvov's head, a misty blue disc, six times the size of Luna as seen from Earth. Half the moon's lit hemisphere was turned away from Lvov, towards Sol.

Like Luna, Charon was tidally locked to its parent, and kept the same face to Pluto as it orbited. But, unlike Earth, Pluto was also locked to its twin. Every six days the worlds turned about each other, facing each other constantly, like two waltzers. Pluto-Charon was the only significant system in which both partners were tidally locked.

Charon's surface looked pocked. Lvov had her face plate enhance the image. Many of the gouges were deep and quite regular.

She remarked on this to Cobh, at the Interface.

"The Poole people mostly used Charon material for the building of the wormhole," Cobh said. "Charon is just rock and water-ice. It's easier to get to water-ice, in particular. Charon doesn't have the inconvenience of an atmosphere, or an overlay of nitrogen-ice over the water. And the gravity's shallower."

The wormhole builders had flown out here in a huge, unreliable GUTship. They had lifted ice and rock off Charon, and used it to construct tetrahedra of exotic matter. The tetrahedra had served as Interfaces, the termini of a wormhole. One interface had been left in orbit around Pluto, and the other had been hauled laboriously back to Jupiter by the GUTship, itself replenished with Charon-ice reaction mass.

By such crude means, Michael Poole and his people had opened up the Solar System.

"They made Lethe's own mess of Charon," Lvov said.

She could almost see Cobh's characteristic shrug. *So what?*

Pluto's surface was geologically complex, here at this point of maximal tidal stress. She flew over ravines and

ridges; in places, it looked as if the land had been smashed up with an immense hammer, cracked and fractured. She imagined there was a greater mix, here, of interior material with the surface ice.

In many places she saw gatherings of the peculiar snowflakes she had noticed before. Perhaps they were some form of frosting effect, she wondered. She descended, thinking vaguely of collecting samples.

She killed the scooter's jets some yards above the surface, and let the little craft fall under Pluto's gentle gravity. She hit the ice with a soft collision, but without heat-damaging the surface features much beyond a few feet.

She stepped off the scooter. The ice crunched, and she felt layers compress under her, but the fractured surface supported her weight. She looked up towards Charon. The crimson moon was immense, round, heavy.

She caught a glimmer of light, an arc, directly above her.

It was gone immediately. She closed her eyes and tried to recapture it. *A line, slowly curving, like a thread. A web. Suspended between Pluto and Charon.*

She looked again, with her face plate set to optimal enhancement. She couldn't recapture the vision.

She didn't say anything to Cobh.

"I was right, by the way," Cobh was saying.

"What?" Lvov tried to focus.

"The wormhole instability, when we crashed. It did cause an Alcubierre wave."

"What's an Alcubierre wave?"

"The Interface's negative energy region expanded from the tetrahedron, just for a moment. The negative energy distorted a chunk of space time. The chunk containing the flitter, and us."

On one side of the flutter, Cobh said, space-time had contracted. Like a model black hole. On the other side, it expanded -- like a re-run of the Big Bang, the expansion at the beginning of the Universe.

"An Alcubierre wave is a front in space-time. The Interface -- with us embedded inside -- was carried along. We were pushed away from the expanding region, and towards the contraction."

"Like a surfer, on a wave."

"Right." Cobh sounded excited. "The effect's been known to theory, almost since the formulation of relativity. But I don't think anyone's observed it before."

"How lucky for us," Lvov said drily. "You said we traveled faster than light. But that's impossible."

"You can't move faster than light *within space-time*. Wormholes are one way of getting around this; in a wormhole you are passing through a branch in space-time. The Alcubierre effect is another way. The superluminal velocity comes from the distortion of space itself; we were carried along *within* distorting space.

"So we weren't breaking lightspeed within our raft of space-time. But that space-time itself was distorting at more than light-speed."

"It sounds like cheating."

"So sue me. Or look up the math."

"Couldn't we use your Alcubierre effect to drive starships?"

"No. The instabilities and the energy drain are forbidding."

One of the snowflake patterns lay mostly undamaged, within Lvov's reach. She crouched and peered at it. The flake was perhaps a foot across. Internal structure was visible within the clear ice as layers of tubes and compartments; it was highly symmetrical, and very complex. She said to Cobh, "This is an impressive

crystallization effect. If that's what it is." Gingerly she reached out with thumb and forefinger, and snapped a short tube off the rim of the flake. She laid the sample on her desk. After a few seconds the analysis presented. "It's mostly water-ice, with some contaminants," she told Cobh. "But in a novel molecular form. Denser than normal ice, a kind of glass. Water would freeze like this under high pressures -- several thousand atmospheres."

"Perhaps it's material from the interior, brought out by the chthonic mixing in that region."

"Perhaps." Lvov felt more confident now; she was intrigued. "Cobh, there's a larger specimen a few feet further away."

"Take it easy, Lvov."

She stepped forward. "I'll be fine. I--"

The surface shattered.

Lvov's left foot dropped forward, into a shallow hole; something crackled under the sole of her boot. Threads of ice crystals, oddly woven together, spun up and tracked precise parabolae around her leg.

The fall seemed to take an age; the ice tipped up towards her like an opening door. She put her hands out. She couldn't stop the fall, but she was able to cushion herself, and she kept her face plate away from the ice. She finished up on her backside; she felt the chill of Pluto ice through the suit material over her buttocks and calves.

"...Lvov? Are you okay?"

She was panting, she found. "I'm fine."

"You were screaming."

"Was I? I'm sorry. I fell."

"You *fell*? How?"

"There was a hole, in the ice." She massaged her left ankle; it didn't seem to be hurt. "It was covered up."

"Show me."

She got to her feet, stepped gingerly back to the open hole, and held up her data desk. The hole was only a few inches deep. "It was covered by a sort of lid, I think."

"Move the desk closer to the hole." Light from the desk, controlled by Cobh, played over the shallow pit.

Lvov found a piece of the smashed lid. It was mostly ice, but there was a texture to its undersurface, embedded thread which bound the ice together.

"Lvov," Cobh said. "Take a look at this."

Lvov lifted the desk aside and peered into the hole. The walls were quite smooth. At the base there was a cluster of spheres, fist-sized. Lvov counted seven; all but one of the spheres had been smashed by her stumble. She picked up the one intact sphere, and turned it over in her hand. It was pearl-gray, almost translucent. There was something embedded inside, disc-shaped, complex.

Cobh sounded breathless. "Are you thinking what I'm thinking?"

"It's an egg," Lvov said. She looked around wildly, at the open pit, the egg, the snowflake patterns. Suddenly she saw the meaning of the scene; it was as if a light had shone up from within Pluto, illuminating her. The "snowflakes" represented *life*, she intuited; they had dug the burrows, laid these eggs, and now their bodies of water glass lay, dormant or dead, on the ancient ice...

"I'm coming down," Cobh said sternly. "We're going to have to discuss this. Don't say anything to the inner System; wait until I get back. This could mean trouble for us, Lvov."

Lvov placed the egg back in the shattered nest.

She met Cobh at the crash scar. Cobh was shoveling nitrogen and water-ice into the life-support modules' raw material hopper. She hooked up her own and Lvov's suits to the modules, recharging the suits' internal systems. Then she began to carve GUTdrive components out of the flitter's

hull. The flitter's central Grand Unified Theory chamber was compact, no larger than a basketball, and the rest of the drive was similarly scaled. "I bet I could get this working," Cobh said. "Although it couldn't take us anywhere."

Lvov sat on a fragment of the shattered hull. Tentatively, she told Cobh about the web.

Cobh stood with hands on hips, facing Lvov, and Lvov could hear her sucking drink from the nipples in her helmet. "Spiders from Pluto? Give me a break."

"It's only an analogy," Lvov said defensively. "I'm an atmospheric specialist, not a biologist." She tapped the surface of her desk. "It's not spider-web. Obviously. But if that substance has anything like the characteristics of true spider silk, it's not impossible." She read from her desk. "Spider silk has a breaking strain twice that of steel, but thirty times the elasticity. It's a type of liquid crystal. It's used commercially -- did you know that?" She fingered the fabric of her suit. "We could be wearing spider silk right now."

"What about the hole with the lid?"

"There are trapdoor spiders in America. On Earth. I remember, when I was a kid... the spiders make burrows, lined with silk, with hinged lids."

"Why make burrows on Pluto?"

"I don't know. Maybe the eggs can last out the winter that way. Maybe the creatures, the flakes, only have active life during the perihelion period, when the atmosphere expands and enriches." She thought that through. "That fits. That's why the Poole people didn't spot anything. It's only fifty-five years since the construction team was here, and even then Pluto was receding from the Sun. Pluto's year is so long that we're still approaching the next aphelion--"

"So how do they live?" Cobh snapped. "What do they eat?"

"There must be more to the ecosystem than one species," Lvov conceded. "The flakes -- the spiders -- need water glass. But there's little of that on the surface. Maybe there is some biocycle -- plants or burrowing animals -- which brings ice and glass to the surface, from the interior."

"That doesn't make sense. The layer of nitrogen over water-ice is too deep."

"Then where do the flakes get their glass?"

"Don't ask me," Cobh said. "It's your dumb hypothesis. And what about the web? What's the point of that -- if it's real?"

Lvov ground to a halt. "I don't know," she said lamely. *Although Pluto/Charon is the only place in the System where you could build a spider-web between worlds.*

Cobh toyed with a fitting from the drive. "Have you told anyone about this yet? In the inner System, I mean."

"No. You said you wanted to talk about that."

"Right." Lvov saw Cobh close her eyes; her face was masked by the glimmer of her face plate. "Listen. Here's what we say. We've seen nothing here. Nothing that couldn't be explained by crystallization effects."

Lvov was baffled. "What are you talking about? What about the eggs? Why would we lie about this? Besides, we have the desks -- records."

"Data desks can be lost, or wiped, or their contents amended."

Lvov wished she could see Cobh's face. "Why would we do such a thing?"

"Think it through. Once Earth hears about this, these flake-spiders of yours will be protected. Won't they?"

"Of course. What's bad about that?"

"It's bad for *us*, Lvov. You've seen what a mess the Poole people made of Charon. If this system is inhabited, *a fast GUTship won't be allowed to come for us*. It wouldn't be

allowed to refuel here. Not if it meant further damage to the native life-forms."

Lvov shrugged. "So we'd have to wait for a slower ship. A liner; one that won't need to take on more reaction mass here."

Cobh laughed at her. "You don't know much about the economics of GUTship transport, do you? Now that the System is criss-crossed by Poole wormholes, how many liners like that do you think are still running? I've already checked the manifests. There are *two* liners capable of a round trip to Pluto still in service. One is in dry dock; the other is heading for Saturn--"

"On the other side of the System."

"Right. There's no way either of those ships could reach us for, I'd say, a year."

*We only have a month's supplies.* A bubble of panic gathered in Lvov's stomach.

"Do you get it yet?" Cobh said heavily. "*We'll be sacrificed*, if there's a chance that our rescue would damage the new ecology, here."

"No. It wouldn't happen like that."

Cobh shrugged. "There are precedents."

She was right, Lvov knew. In the case of the "tree stump" life-forms discovered on a remote Kuiper object, the territory had been ring-fenced, the local conditions preserved, once life -- even a plausible candidate for life -- was recognized.

Cobh said, "Pan-genetic diversity. Pan-environmental management. That's the key to it; the public policy of preserving all the species and habitats of Sol, into the indefinite future. The lives of two humans won't matter a damn against that."

"What are you suggesting?"

"That we don't tell the inner System about the flakes."



Lvov tried to recapture her mood of a few days before: when Pluto hadn't mattered to her, when the crash had been just an inconvenience. *Now, suddenly, we're talking about threats to our lives, the destruction of an ecology.*

*What a dilemma. If I don't tell of the flakes, their ecology may be destroyed during our rescue. But if I do tell, the GUTship won't come for me, and I'll lose my life.*

Cobh seemed to be waiting for an answer.

Lvov thought of how Sol light looked over Pluto's ice fields, at dawn.

She decided to stall. "We'll say nothing. For now. But I don't accept either of your options."

Cobh laughed. "What else is there? The wormhole is destroyed; even this flutter is disabled."

"We have time. Days, before the GUTship is due to be launched. Let's search for another solution. A win-win."

Cobh shrugged. She looked suspicious.

*She's right to be,* Lvov thought, exploring her own decision with surprise. *I've every intention of telling the truth later, of diverting the GUTship, if I have to.*

*I may give up my life, for this world.*

*I think.*

In the days that followed, Cobh tinkered with the GUTdrive, and flew up to the Interface to gather more data on the Alcubierre phenomenon.

Lvov roamed the surface of Pluto, with her desk set to full record. She came to love the wreaths of cirrus clouds, the huge, misty moon, the slow, oceanic pulse of the centuries-long year.

Everywhere she found the inert bodies of snowflakes, or evidence of their presence: eggs, lidded burrows. She found no other life-forms -- or, more likely, she told herself, she wasn't equipped to recognize any others.

She was drawn back to Christy, the sub-Charon point, where the topography was at its most complex and interesting, and where the greatest density of flakes was to be found. It was as if, she thought, the flakes had gathered here, yearning for the huge, inaccessible moon above them. But what could the flakes possibly want of Charon? What did it mean for them?

Lvov encountered Cobh at the crash scar, recharging her suit's systems from the life-support packs. Cobh seemed quiet. She kept her face, hooded by her face plate, turned from Lvov.

Lvov watched her for a while. "You're being evasive," she said eventually. "Something's changed -- something you're not telling me about."

Cobh made to turn away, but Lvov grabbed her arm. "*I think you've found a third option.* Haven't you? You've found some other way to resolve this situation, without destroying either us or the flakes."

Cobh shook off her hand. "Yes. Yes, I think I know a way. But--"

"But what?"

"It's *dangerous*, damn it. Maybe unworkable. Lethal." Cobh's hands pulled at each other.

*She's scared*, Lvov saw. She stepped back from Cobh. Without giving herself time to think about it, she said, "Our deal's off. I'm going to tell the inner System about the flakes. Right now. So we're going to have to go with your new idea, dangerous or not."

Cobh studied her face; Cobh seemed to be weighing up Lvov's determination, perhaps even her physical strength. Lvov felt as if she were a data desk being downloaded. The moment stretched, and Lvov felt her breath tighten in her chest. Would she be able to defend herself, physically, if it came to that? And -- was her own will really so strong?

*I have changed, she thought. Pluto has changed me.*

At last Cobh looked away. "Send your damn message," she said.

Before Cobh -- or Lvov herself -- had a chance to waver, Lvov picked up her desk and sent a message to the inner worlds. She downloaded all the data she had on the flakes: text, images, analyses, her own observations and hypotheses.

"It's done," she said at last.

"And the GUTship?"

"I'm sure they'll cancel it." Lvov smiled. "I'm also sure they won't tell us they've done so."

"So we're left with no choice," Cobh said angrily. "Look: I know it's the right thing to do. To preserve the flakes. I just don't want to die, that's all. I hope you're right, Lvov."

"You haven't told me how we're going to get home."

Cobh grinned through her face plate. "Surfing."

"All right. You're doing fine. Now let go of the scooter."

Lvov took a deep breath, and kicked the scooter away with both legs; the little device tumbled away, catching the deep light of Sol, and Lvov rolled in reaction.

Cobh reached out and steadied her. "You can't fall," Cobh said. "You're in orbit. You understand that, don't you?"

"Of course I do," Lvov grumbled.

The two of them drifted in space, close to the defunct Poole wormhole Interface. The Interface itself was a tetrahedron of electric blue struts, enclosing darkness, its size overwhelming; Lvov felt as if she was floating beside the carcass of some huge, wrecked building.

Pluto and Charon hovered before her like balloons, their surfaces mottled and complex, their forms visibly distorted from the spherical. Their separation was only fourteen Pluto-diameters. The worlds were strikingly different in hue, with Pluto a blood red, Charon ice blue. *That's the*

*difference in surface composition*, Lvov thought absently. *All that water-ice on Charon's surface.*

The panorama was stunningly beautiful. Lvov had a sudden, gut-level intuition of the *rightness* of the various System authorities' rigid pan-environment policies.

Cobh had strapped her data desk to her chest; now she checked the time. "Any moment now. Lvov, you'll be fine. Remember, you'll feel no acceleration, no matter how fast we travel. At the center of an Alcubierre wave, space-time is locally flat; you'll still be in free fall. There will be tidal forces, but they will remain small. Just keep your breathing even, and--"

"Shut up, Cobh," Lvov said tightly. "I know all this."

Cobh's desk flared with light. "*There*," she breathed. The GUT-drive has fired. "Just a few seconds, now."

A spark of light arced up from Pluto's surface and tracked, in complete silence, under the belly of the parent world. It was the flitter's GUTdrive, salvaged and stabilized by Cobh. The flame was brighter than Sol; Lvov saw its light reflected in Pluto, as if the surface was a great, fractured mirror of ice. Where the flame passed, tongues of nitrogen gas billowed up.

The GUTdrive passed over Christy. Lvov had left her desk there, to monitor the flakes, and the image the desk transmitted, displayed in the corner of her face plate, showed a spark, crossing the sky.

Then the GUTdrive veered sharply upwards, climbing directly towards Lvov and Cobh at the Interface.

"Cobh, are you sure this is going to work?"

Lvov could hear Cobh's breath rasp, shallow. "Look, Lvov, I know you're scared, but pestering me with dumb-ass questions isn't going to help. Once the drive enters the Interface, it will take only seconds for the instability to set in. Seconds, and then we'll be home. In the inner System, at any rate. Or..."

"Or what?"

Cobh didn't reply.

*Or not, Lvov finished for her. If Cobh has designed this new instability right, the Alcubierre wave will carry us home. If not --*

The GUTdrive flame approached, becoming dazzling. Lvov tried to regulate her breathing, to keep her limbs hanging loose--

"Lethe," Cobh whispered.

"What?" Lvov demanded, alarmed.

"Take a look at Pluto. At Christy."

Lvov looked into her face plate.

Where the warmth and light of the GUTdrive had passed, Christy was a ferment. Nitrogen billowed. And, amid the pale fountains, burrows were opening. Lids folded back. Eggs cracked. Infant flakes soared and sailed, with webs and nets of their silk-analogue hauling at the rising air.

Lvov caught glimpses of threads, long, sparkling, trailing down to Pluto -- and up towards Charon. Already, Lvov saw, some of the baby flakes had hurtled more than a planetary diameter from the surface, towards the moon.

"It's goose summer," she said.

"What?"

"When I was a kid... the young spiders spin bits of webs, and climb to the top of grass stalks, and float off on the breeze. Goose summer -- *gossamer*."

"Right," Cobh said skeptically. "Well, it looks as if they are making for Charon. They use the evaporation of the atmosphere for lift... Perhaps they follow last year's threads, to the moon. They must fly off every perihelion, rebuilding their web bridge every time. They think the perihelion is here now. The warmth of the drive -- it's remarkable. But why go to Charon?"

Lvov couldn't take her eyes off the flakes. "Because of the water," she said. It all seemed to make sense, now that she saw the flakes in action. "There must be water glass, on Charon's surface. The baby flakes use it to build their bodies. They take other nutrients from Pluto's interior, and the glass from Charon... They need the resources of *both* worlds to survive--"

"Lvov!"

The GUTdrive flared past them, sudden, dazzling, and plunged into the damaged Interface.

Electric-blue light exploded from the Interface, washing over her.

There was a ball of light, unearthly, behind her, and an irregular patch of darkness ahead, like a rip in space. Tidal forces plucked gently at her belly and limbs.

Pluto, Charon and goose summer disappeared. But the stars, the eternal stars, shone down on her, just as they had during her childhood on Earth. She stared at the stars, trusting, and felt no fear.

Remotely, she heard Cobh whoop, exhilarated.

The tides faded. The darkness before her healed, to reveal the brilliance and warmth of Sol.

*It was a time of extraordinary ambition and achievement. The anthropic theories of cosmological evolution were somewhere near their paradigmatic peak. Some believed humans were alone in the Universe. Others even believed the Universe had been designed, by some offstage agency, with the sole object of delivering and supporting humans.*

*Given time, humans could do anything, go anywhere, achieve whatever they liked.*

*Michael Poole was rightly celebrated for his achievements. His wormhole projects had opened up the*

*System much as the great railroads had opened up the American continent, two thousand years earlier.*

*But Poole had greater ambitions in mind.*

*Poole used wormhole technology to establish a time tunnel: a bridge across fifteen hundred years, to the future.*  
[\[2\]](#)

*Why was Poole's wormhole time link built?*

*There were endless justifications -- what power could a glimpse of the future afford? -- but the truth was that it had been built for little more than the sheer joy of it.*

*But Poole's bridge reached an unexpected future.*

*The incident that followed the opening of the wormhole was confused, chaotic, difficult to disentangle. But it was a war -- brief, spectacular, like no battle fought in Solar space before -- but a war nevertheless. It was an invasion from a remote future, in which the Solar System had been occupied by an alien power.*

*The incursion was repelled. Michael Poole drove a captured warship into the wormhole, to seal it against further invasion. In the process, Poole himself was lost in time.*

*The System, stunned, slowly returned to normal.*

*Various bodies combed through the fragments of data from the time bridge incident, trying to answer the unanswerable.*

*It was said that before Poole's wormhole path to the future finally closed, some information had been obtained on the far future. And the rumors said that the future -- and what it held for mankind -- were bleak indeed.*

*If the data was anything like accurate, it was clear that there was an agency at large -- which must be acting even now -- systematically destroying the stars...*

*And, as a consequence, humanity.*

*In response, an organization called the Holy Superet Church of Light emerged and evolved. Superet believed that humanity was becoming mature, as a species. And it was time to take responsibility for man's long-term survival as a species.*

*Eve said, "A fresh starship was launched, called the Great Northern, in an attempt to build a new time bridge. And probes were prepared to investigate the heart of man's own star, the Sun, where a dark cancer was growing..."[\[3\]](#)*



## Cilia-of-Gold

**A.D. 3948**

The people -- though exhausted by the tunnel's cold -- had rested long enough, Cilia-of-Gold decided.

Now it was time to fight.

She climbed up through the water, her flukes pulsing, and prepared to lead the group further along the Ice-tunnel to the new Chimney cavern.

But, even as the people rose from their browsing and crowded through the cold, stale water behind her, Cilia-of-Gold's resolve wavered. The Seeker was a heavy presence inside her. She could *feel* its tendrils wrapped around her stomach, and -- she knew -- its probes must already have penetrated her brain, her mind, her *self*.

With a beat of her flukes, she thrust her body along the tunnel. She couldn't afford to show weakness. Not now.

"Cilia-of-Gold."

A broad body, warm through the turbulent water, came pushing out of the crowd to bump against hers: it was Strong-Flukes, one of Cilia-of-Gold's Three-mates. Strong-Flukes' presence was immediately comforting. "Cilia-of-Gold. I know something's wrong."

Cilia-of-Gold thought of denying it; but she turned away, her depression deepening. "I couldn't expect to keep secrets from you. Do you think the others are aware?"

The hairlike cilia lining Strong-Flukes' belly barely vibrated as she spoke. "Only Ice-Born suspects something is wrong. And if she didn't, we'd have to tell her." Ice-Born was the third of Cilia-of-Gold's mates.

"I can't afford to be weak, Strong-Flukes. Not now."

As they swam together, Strong-Flukes flipped onto her back. Tunnel water filtered between Strong-Flukes' carapace and her body; her cilia flickered as they plucked particles of food from the stream and popped them into the multiple mouths along her belly. "Cilia-of-Gold," she said. "I *know* what's wrong. You're carrying a Seeker, aren't you?"

"...Yes. How could you tell?"

"I love you," Strong-Flukes said. "*That's* how I could tell."

The pain of Strong-Flukes' perception was as sharp, and unexpected, as the moment when Cilia-of-Gold had first detected the signs of the infestation in herself... and had realized, with horror, that her life must inevitably end in madness, in a purposeless scrabble into the Ice over the world. "It's still in its early stages, I think. It's like a huge heat, inside me. And I can feel it reaching into my mind. Oh, Strong-Flukes..."

"Fight it."

"I can't. I--"

"You can. You *must*."

The end of the tunnel was an encroaching disc of darkness; already Cilia-of-Gold could feel the inviting warmth of the Chimney-heated water on the cavern beyond.

This should have been the climax, the supreme moment of Cilia-of-Gold's life.

The group's old Chimney, with its fount of warm, rich water, was failing; and so they had to flee, and fight for a place in a new cavern.

That, or die.

It was Cilia-of-Gold who had found the new Chimney, as she had explored the endless network of tunnels between the Chimney caverns. Thus, it was she who must lead this war -- Seeker or no Seeker.

She gathered up the fragments of her melting courage.

"You're the best of us, Cilia-of-Gold," Strong-Flukes said, slowing. "Don't ever forget that."

Cilia-of-Gold pressed her carapace against Strong-Flukes' in silent gratitude.

Cilia-of-Gold turned and clacked her mandibles, signaling the rest of the people to halt. They did so, the adults sweeping the smaller children inside their strong carapaces.

Strong-Flukes lay flat against the floor and pushed a single eye stalk towards the mouth of the tunnel. Her caution was wise; there were species who could home in on even a single sound-pulse from an unwary eye.

After some moments of silent inspection, Strong-Flukes wriggled back along the Ice surface to Cilia-of-Gold.

She hesitated. "We've got problems, I think," she said at last.

The Seeker seemed to pulse inside Cilia-of-Gold, tightening around her gut. "What problems?"

"This Chimney's inhabited already. By *Heads*."

Kevan Scholes stopped the rover a hundred yards short of the wall-mountain's crest.

Irina Larionova, wrapped in a borrowed environment suit, could tell from the tilt of the cabin that the surface here was inclined upwards at around forty degrees -- shallower than a flight of stairs. This "mountain," heavily eroded, was really little more than a dust-clad hill, she thought.

"The wall of Chao Meng-Fu Crater," Scholes said briskly, his radio-distorted voice tinny. "Come on. We'll walk to the summit from here."

"Walk?" She studied him, irritated. "Scholes, I've had one hour's sleep in the last thirty-six; I've traveled across ninety million miles to get here, via flitters and wormhole transit links -- and you're telling me I have to *walk* up this damn hill?"

Scholes grinned through his face plate. He was AS-preserved at around physical-twenty-five, Larionova guessed, and he had a boyishness that grated on her. *Damn it*, she reminded herself, *this "boy" is probably older than me*.

"Trust me," he said. "You'll love the view. And we have to change transports anyway."

"Why?"

"You'll see."

He twisted gracefully to his feet. He reached out a gloved hand to help Larionova pull herself, awkwardly, out of her seat. When she stood on the cabin's tilted deck, her heavy boots hurt her ankles.

Scholes threw open the rover's lock. Residual air puffed out of the cabin, crystallizing. The glow from the cabin interior was dazzling; beyond the lock, Larionova saw only darkness.

Scholes climbed out of the lock and down to the planet's invisible surface. Larionova followed him awkwardly; it seemed a long way to the lock's single step.

Her boots settled to the surface, crunching softly. The lock was situated between the rover's rear wheels: the wheels were constructs of metal strips and webbing, wide and light, each wheel taller than she was.

Scholes pushed the lock closed, and Larionova was plunged into sudden darkness.

Scholes loomed before her. He was a shape cut out of blackness. "Are you okay? Your pulse is rapid."

She could hear the rattle of her own breath, loud and immediate. "Just a little disoriented."

"We've got all of a third of a gee down here, you know. You'll get used to it. Let your eyes dark-adapt. We don't have to hurry this."

She looked up.

In her peripheral vision, the stars were already coming out. She looked for a bright double star, blue and white. There it was: Earth, with Luna.

And now, with a slow grandeur, the landscape revealed itself to her adjusting eyes. The plain from which the rover had climbed spread out from the foot of the crater wall-mountain. It was a complex patchwork of crowding craters, ridges and scarps -- some of which must have been miles high -- all revealed as a glimmering tracery in the starlight. The face of the planet seemed *wrinkled*, she thought, as if shrunk with age.

"These wall-mountains are over a mile high," Scholes said. "Up here, the surface is firm enough to walk on; the regolith dust layer is only a couple of inches thick. But down on the plain the dust can be ten or fifteen yards deep. Hence the big wheels on the rover. I guess that's what five billion years of thousand-degree temperature range does for a landscape..."

Just twenty-four hours ago, she reflected, Larionova had been stuck in a boardroom in New York, buried in one of Superet's endless funding battles. And now this... wormhole travel was bewildering. "Lethe's waters," she said. "It's so -- desolate."

Scholes gave an ironic bow. "Welcome to Mercury," he said.

Cilia-of-Gold and Strong-Flukes peered down into the Chimney cavern.

Cilia-of-Gold had chosen the cavern well. The Chimney here was a fine young vent, a glowing crater much wider than their old, dying home. The water above the Chimney was turbulent, and richly cloudy; the cavern itself was wide and smooth-walled. Cilia-plants grew in mats around the Chimney's base. Cutters browsed in turn on the cilia-plants, great chains of them, their tough little arms slicing steadily through the plants. Sliding through the plant mats Cilia-of-

Gold could make out the supple form of a Crawler, its mindless, tubelike body wider than Cilia-of-Gold's and more than three times as long...

And, stalking around their little forest, here came the Heads themselves, the rulers of the cavern. Cilia-of-Gold counted four, five, six of the Heads, and no doubt there were many more in the dark recesses of the cavern.

One Head -- close to the tunnel mouth -- swiveled its huge, swollen helmet-skull towards her.

She ducked back into the tunnel, aware that all her cilia were quivering.

Strong-Flukes drifted to the tunnel floor, landing in a little cloud of food particles. "*Heads*," she said, her voice soft with despair. "We can't fight Heads."

The Heads' huge helmet-skulls were sensitive to heat -- fantastically so, enabling the Heads to track and kill with almost perfect accuracy. Heads *were* deadly opponents, Cilia-of-Gold reflected. But the people had nowhere else to go.

"We've come a long way, to reach this place, Strong-Flukes. If we had to undergo another journey--" *through more cold, stagnant tunnels* " -- many of us couldn't survive. And those who did would be too weakened to fight.

"No. We have to stay here -- to *fight* here."

Strong-Flukes groaned, wrapping her carapace close around her. "Then we'll all be killed."

Cilia-of-Gold tried to ignore the heavy presence of the Seeker within her -- and its prompting, growing more insistent now, that she *get away* from all this, from the crowding presence of people -- and she forced herself to *think*.

Larionova followed Kevan Scholes up the slope of the wall-mountain. Silicate surface dust compressed under her boots, like fine sand. The climbing was easy -- it was no

more than a steep walk, really -- but she stumbled frequently, clumsy in this reduced gee.

They reached the crest of the mountain. It wasn't a sharp summit: more a wide, smooth platform, fractured to dust by Mercury's wild temperature range.

"Chao Meng-Fu Crater," Scholes said. "A hundred miles wide, stretching right across Mercury's South Pole."

The crater was so large that even from this height its full breadth was hidden by the tight curve of the planet. The wall-mountain was one of a series that swept across the landscape from left to right, like a row of eroded teeth, separated by broad, rubble-strewn valleys. On the far side of the summit, the flanks of the wall-mountain swept down to the plain of the crater, a full mile below.

Mercury's angry Sun was hidden beyond the curve of the world, but its corona extended delicate, structured tendrils above the far horizon.

The plain itself was immersed in darkness. But by the milky, diffuse light of the corona, Larionova could see a peak at the center of the plain, shouldering its way above the horizon. There was a spark of light at the base of the central peak, incongruously bright in the crater's shadows: that must be the Thoth team's camp.

"This reminds me of the Moon," she said.

Scholes considered this. "Forgive me, Dr. Larionova. Have you been down to Mercury before?"

"No," she said, his easy, informed arrogance grating on her. "I'm here to oversee the construction of Thoth, not to sightsee."

"Well, there's obviously a superficial similarity. After the formation of the main System objects five billion years ago, all the inner planets suffered bombardment by residual planetesimals. That's when Mercury took its biggest strike: the one which created the Caloris feature. But after that, Mercury was massive enough to retain a molten core -- unlike the Moon. Later planetesimal strikes punched holes

in the crust, so there were lava outflows that drowned some of the older cratering.

"Thus, on Mercury, you have a mixture of terrains. There's the most ancient landscape, heavily cratered, and the *planitia*: smooth lava plains, punctured by small, young craters.

"Later, as the core cooled, the surface actually shrunk inwards. The planet lost a mile or so of radius."

Like a dried-out tomato. "So the surface is wrinkled."

"Yes. There are *rupes* and *dorsa*: ridges and lobate scarps, cliffs a couple of miles tall and extending for hundreds of miles. Great climbing country. And in some places there are gas vents, chimneys of residual thermal activity." He turned to her, corona light misty in his face plate. "So Mercury isn't really so much like the Moon at all... Look. You can see Thoth."

She looked up, following his pointing arm. There, just above the far horizon, was a small blue star.

She had her face plate magnify the image. The star exploded into a compact sculpture of electric blue threads, surrounded by firefly lights: the Thoth construction site.

Thoth was a habitat to be placed in orbit close to Sol. Irina Larionova was the consulting engineer contracted by Superet to oversee the construction of the habitat.

At Thoth, a Solar-interior probe would be constructed. The probe would be one Interface of a wormhole, loaded with sensors. The Interface would be dropped into the Sun. The other Interface would remain in orbit, at the center of the habitat.

Thoth's purpose was to find out what was wrong with the Sun.

Irina Larionova wasn't much interested in the purpose of Thoth, or any of Superet's semi-mystical philosophizing. It was the work that was important, for her: and the engineering problems posed by Thoth were fascinating.



The electric-blue bars she could see now were struts of exotic matter, which would eventually frame the wormhole termini. The sparks of light moving around the struts were GUTships and short-haul flitters. She stared at the image, wishing she could get back to some real work.

Irina Larionova had had no intention of visiting Mercury herself. Mercury was a detail, for Thoth. Why would *anyone* come to Mercury, unless they had to? Mercury was a piece of junk, a desolate ball of iron and rock too close to the Sun to be interesting, or remotely habitable. The two Thoth exploratory teams had come here only to exploit: to see if it was possible to dig raw materials out of Mercury's shallow - - and close-at-hand -- gravity well, for use in the construction of the habitat. The teams had landed at the South Pole, where traces of water-ice had been detected, and at the Caloris Basin, the huge equatorial crater where - - it was hoped -- that ancient impact might have brought iron-rich compounds to the surface.

The flitters from Thoth actually comprised the largest expedition ever to land on Mercury.

But, within days of landing, both investigative teams had reported anomalies.

Larionova tapped at her suit's sleeve-controls. After a couple of minutes an image of Dolores Wu appeared in one corner of Larionova's face plate. *Hi, Irina*, she said, her voice buzzing like an insect in Larionova's helmet's enclosed space.

Dolores Wu was the leader of the Thoth exploratory team in Caloris. Wu was Mars-born, with small features and hair grayed despite AntiSenescence treatments. She looked weary.

"How's Caloris?" Larionova asked.

*Well, we don't have much to report yet. We decided to start with a detailed gravimetric survey...*

"And?"

*We found the impact object. We think. It's as massive as we thought, but much -- much -- too small, Irina. It's barely a mile across, way too dense to be a planetesimal fragment.*

"A black hole?"

*No. Not dense enough for that.*

"Then what?"

*Wu looked exasperated. We don't know yet, Irina. We don't have any answers. I'll keep you informed.*

Wu closed off the link.

Standing on the corona-lit wall of Chao Meng-Fu Crater, Larionova asked Kevan Scholes about Caloris.

"Caloris is *big*," he said. "Luna has no impact feature on the scale of Caloris. And Luna has nothing like the Weird Country in the other hemisphere..."

"The what?"

A huge planetesimal -- or *something* -- had struck the equator of Mercury, five billion years ago, Scholes said. The Caloris Basin -- an immense, ridged crater system -- formed around the primary impact site. Whatever caused the impact was still buried in the planet, somewhere under the crust, dense and massive; the object was a gravitational anomaly which had helped lock Mercury's rotation into synchronization with its orbit.

"Away from Caloris itself, shock waves spread around the planet's young crust," Scholes said. "The waves focused at Caloris' antipode -- the point on the equator diametrically opposite Caloris itself. And the land there was shattered, into a jumble of bizarre hill and valley formations. *The Weird Country*... hey. Dr. Larionova."

She could *hear* that damnable grin of Scholes's. "What now?" she snapped.

He walked across the summit towards her. "Look up," he said.

"Damn it, Scholes--"

There was a pattering against her face plate.

She tilted up her head. Needle-shaped particles swirled over the wall-mountain from the planet's dark side and bounced off her face plate, sparkling in corona light.

"What in Lethe is that?"

"Snow," he said.

*Snow... on Mercury?*

In the cool darkness of the tunnel, the people clambered over each other; they bumped against the Ice walls, and their muttering filled the water with criss-crossing voice-ripples. Cilia-of-Gold swam through and around the crowd, coaxing the people to follow her will.

She felt immensely weary. Her concentration and resolve threatened continually to shatter under the Seeker's assault. And the end of the tunnel, with the deadly Heads beyond, was a looming, threatening mouth, utterly intimidating.

At last the group was ready. She surveyed them. All of the people -- except the very oldest and the very youngest -- were arranged in an array which filled the tunnel from wall to wall; she could hear flukes and carapaces scraping softly against Ice.

The people looked weak, foolish, eager, she thought with dismay; now that she was actually implementing it her scheme seemed simple-minded. Was she about to lead them all to their deaths?

But it was too late for the luxury of doubt, she told herself. Now, there was no other option to follow.

She lifted herself to the axis of the tunnel, and clacked her mandibles sharply.

"Now," she said, "it is time. The most important moment of your lives. And you must *swim!* Swim as hard as you can; swim for your lives!"

And the people responded.

There was a surge of movement, of almost exhilarating *intent*. The people beat their flukes as one, and a jostling

mass of flesh and carapaces scrapped down the tunnel.

Cilia-of-Gold hurried ahead of them, leading the way towards the tunnel mouth. As she swam she could feel the current the people were creating, the plug of cold tunnel water they pushed ahead of themselves.

Within moments the tunnel mouth was upon her.

She burst from the tunnel, shooting out into the open water of the cavern, her carapace clenched firm around her. She was plunged immediately into a clammy heat, so great was the temperature difference between tunnel and cavern.

Above her the Ice of the cavern roof arched over the warm chimney mouth. And from all around the cavern, the helmet skulls of Heads snapped around towards her.

Now the people erupted out of the tunnel, a shield of flesh and chitin behind her. The rush of tunnel water they pushed ahead of themselves washed over Cilia-of-Gold, chilling her new.

She tried to imagine this from the Heads' point of view. This explosion of cold water into the cavern would bring about a much greater temperature difference than the Heads' heat-sensor skulls were accustomed to; the Heads would be *dazzled*, at least for a time: long enough -- she hoped -- to give her people a fighting chance against the more powerful Heads.

She swiveled in the water. She screamed at her people, so loud she could feel her cilia strain at the turbulent water. "Now! Hit them now!"

The people, with a roar, descended towards the Heads.

Kevan Scholes led Larionova down the wall-mountain slope into Chao Meng-Fu Crater.

After a hundred yards they came to another rover. This car was similar to the one they'd abandoned on the other side of the summit, but it had an additional fitting,

obviously improvised: two wide, flat rails of metal, suspended between the wheels on hydraulic legs.

Scholes helped Larionova into the rover and pressurized it. Larionova removed her helmet with relief. The rover smelled, oppressively, of metal and plastic.

While Scholes settled behind his controls, Larionova checked the rover's data desk. An update from Dolores Wu was waiting for her. Wu wanted Larionova to come to Caloris, to see for herself what had been found there. Larionova sent a sharp message back, ordering Wu to summarize her findings and transmit them to the data desks at the Chao site.

Wu acknowledged immediately, but replied: *I'm going to find this hard to summarize, Irina.*

Larionova tapped out: *Why?*

*We think we've found an artifact.*

Larionova stared at the blunt words on the screen.

She massaged the bridge of her nose; she felt an ache spreading out from her temples and around her eye sockets. She wished she had time to sleep.

Scholes started the vehicle up. The rover bounced down the slope, descending into shadow. "It's genuine water-ice snow," Scholes said as he drove. "You know that a day on Mercury lasts a hundred and seventy-six Earth days. It's a combination of the eighty-eight-day year and the tidally locked rotation, which--"

"I know."

"During the day, the Sun drives water vapor out of the rocks and into the atmosphere."

"What atmosphere?"

"You really don't know much about Mercury, do you? It's mostly helium and hydrogen -- only a billionth of Earth's sea-level pressure."

"How come those gases don't escape from the gravity well?"

"They do," Scholes said. "But the atmosphere is replenished by the Solar wind. Particles from the Sun are trapped by Mercury's magnetosphere. Mercury has quite a respectable magnetic field: the planet has a solid iron core, which..."

She let Scholes' words run on through her head, unregistered. *Air from the Solar wind, and snow at the South Pole...*

Maybe Mercury was a more interesting place than she'd imagined.

"Anyway," Scholes was saying, "the water vapor disperses across the planet's sunlit hemisphere. But at the South Pole we have this crater: Chao Meng-Fu, straddling the Pole itself. Mercury has no axial tilt -- there are no seasons here -- and so Chao's floor is in permanent shadow."

"And snow falls."

"And snow falls."

Scholes stopped the rover and tapped telltales on his control panel. There was a whir of hydraulics, and she heard a soft crunch, transmitted into the cabin through the rover's structure.

Then the rover lifted upwards through a foot.

The rover lurched forward again. The motion was much smoother than before, and there was an easy, hissing sound.

"You've just lowered those rails," Larionova said. "I knew it. This damn rover is a sled, isn't it?"

"It was easy enough to improvise," Scholes said, sounding smug. "Just a couple of metal rails on hydraulics, and vernier rockets from a cannibalized flitter to give us some push..."

"It's astonishing that there's enough ice here to sustain this."

"Well, that snow may have seemed sparse, but it's been falling steadily -- for five billion years... Dr. Larionova, there's a whole frozen ocean here, in Chao Meng-Fu Crater: enough ice to be detectable even from Earth."

Larionova twisted to look out through a viewport at the back of the cabin. The rover's rear lights picked out twin sled tracks, leading back to the summit of the wall-mountain; ice, exposed in the tracks, gleamed brightly in starlight.

*Lethe, she thought. Now I'm skiing. Skiing, on Mercury. What a day.*

The wall-mountain shallowed out, merging seamlessly with the crater plain. Scholes retracted the sled rails; on the flat, the regolith dust gave the ice sufficient traction for the rover's wide wheels. The rover made fast progress through the fifty miles to the heart of the plain.

Larionova drank coffee and watched the landscape through the view ports. The corona light was silvery and quite bright here, like Moonlight. The central peak loomed up over the horizon, like some approaching ship on a sea of dust. The ice surface of Chao's floor -- though packed with craters and covered with the ubiquitous regolith dust -- was visibly smoother and more level than the plain outside the crater.

The rover drew to a halt on the outskirts of the Thoth team's sprawling camp, close to the foothills of the central peak. The dust here was churned up by rover tracks and flitter exhaust splashes, and semitransparent bubble-shelters were hemispheres of yellow, homely light, illuminating the darkened ice surface. There were drilling rigs, and several large pits dug into the ice.

Scholes helped Larionova out onto the surface. "I'll take you to a shelter," he said. "Or a flitter. Maybe you want to freshen up before--"

"Where's Dixon?"

Scholes pointed to one of the rigs. "When I left, over there."

"Then that's where we're going. Come on."

Frank Dixon was the team leader. He met Larionova on the surface, and invited her into a small opaqued bubble-shelter nestling at the foot of the rig.

Scholes wandered off into the camp, in search of food.

The shelter contained a couple of chairs, a data desk, and a basic toilet. Dixon was a morose, burly American; when he took off his helmet there was a band of dirt at the base of his wide neck, and Larionova noticed a sharp, acrid stink from his suit. Dixon had evidently been out on the surface for long hours.

He pulled a hip flask from an environment suit pocket. "You want a drink?" he asked. "Scotch?"

"Sure."

Dixon poured a measure for Larionova into the flask's cap, and took a draught himself from the flask's small mouth.

Larionova drank; the liquor burned her mouth and throat, but it immediately took an edge off her tiredness. "It's good. But it needs ice."

He smiled. "Ice we got. Actually, we have tried it; Mercury ice is good, as clean as you like. We're not going to die of thirst out here, Irina."

"Tell me what you've found, Frank."

Dixon sat on the edge of the desk, his fat haunches bulging inside the leggings of his environment suit. "Trouble, Irina. We've found trouble."

"I know that much."

"I think we're going to have to get off the planet. The System authorities -- and the scientists and conservation groups -- are going to climb all over us, if we try to mine here. I wanted to tell you about it, before--"



Larionova struggled to contain her irritation and tiredness. "That's *not* a problem for Thoth," she said. "Therefore it's not a problem for me. We can tell Superet to bring in a water-ice asteroid from the Belt, for our supplies. You know that. Come on, Frank. Tell me why you're wasting my time down here."

Dixon took another long pull on his flask, and eyed her.

"There's *life* here, Irina," he said. "Life, inside this frozen ocean. Drink up; I'll show you."

The sample was in a case on the surface, beside a data desk. The thing in the case looked like a strip of multicolored meat: perhaps three feet long, crushed and obviously dead; shards of some transparent shell material were embedded in flesh that sparkled with ice crystals.

"We found this inside a two-thousand-yard-deep core," Dixon said.

Larionova tried to imagine how this would have looked, intact and mobile. "This means nothing to me, Frank. I'm no biologist."

He grunted, self-deprecating. "Nor me. Nor any of us. Who expected to find life, on Mercury?" Dixon tapped at the data desk with gloved fingers. "We used our desks' medico-diagnostic facilities to come up with this reconstruction," he said. "We call it a *mercuric*, Irina."

A Virtual projected into space a foot above the desk's surface; the image rotated, sleek and menacing.

The body was a thin cone, tapering to a tail from a wide, flat head. Three parabolic cups -- *eyes?* -- were embedded in the smooth "face," symmetrically placed around a lipless mouth... No, not eyes, Larionova corrected herself. Maybe some kind of sonar sensor? That would explain the parabolic profile.

Mandibles, like pincers, protruded from the mouth. From the tail, three fins were splayed out around what looked like an anus. A transparent carapace surrounded the

main body, like a cylindrical cloak; inside the carapace, rows of small, hairlike cilia lined the body, supple and vibratile.

There were regular markings, faintly visible, in the surface of the carapace.

"Is this accurate?"

"Who knows? It's the best we can do. When we have your clearance, we can transmit our data to Earth, and let the experts get at it."

"Lethe, Frank," Larionova said. "This looks like a fish. It looks like it could *swim*. The streamlining, the tail--"

Dixon scratched the short hairs at the back of his neck and said nothing.

"But we're on Mercury, damn it, not in Hawaii," Larionova said.

Dixon pointed down, past the dusty floor. "Irina. It's not all frozen. There are *cavities* down there, inside the Chao ice cap. According to our sonar probes--"

"Cavities?"

"Water. At the base of the crater, under a couple of miles of ice. Kept liquid by thermal vents, in crust-collapse scarps and ridges. Plenty of room for swimming... we speculate that our friend here swims on his back--" he tapped the desk surface, and the image swiveled " -- and the water passes down, between his body and this carapace, and he uses all those tiny hairs to filter out particles of food. The trunk seems to be lined with little mouths. See?" He flicked the image to another representation; the skin became transparent, and Larionova could see blocky reconstructions of internal organs. Dixon said, "There's no true stomach, but there is what looks like a continuous digestive tube passing down the axis of the body, to the anus at the tail."

Larionova noticed a threadlike structure wrapped around some of the organs, as well as around the axial

digestive tract.

"Look," Dixon said, pointing to one area. "Look at the surface structure of these lengths of tubing, here near the digestive tract."

Larionova looked. The tubes, clustering around the digestive axis, had complex, rippled surfaces. "So?"

"You don't get it, do you? It's *convoluted* -- like the surface of a brain. Irina, we think that stuff must be some equivalent of nervous tissue."

Larionova frowned. *Damn it, I wish I knew more biology.* "What about this thread material, wrapped around the organs?"

Dixon sighed. "We don't know, Irina. It doesn't seem to fit with the rest of the structure, does it?" He pointed. "Follow the threads back. There's a broader main body, just here. We think maybe this is some kind of parasite, which has infested the main organism. Like a tapeworm. It's as if the threads are extended, vestigial limbs..."

Leaning closer, Larionova saw that tendrils from the wormthing had even infiltrated the brain-tubes. She shuddered; if this was a parasite, it was a particularly vile infestation. Maybe the parasite even modified the mercuric's behavior, she wondered.

Dixon restored the solid-aspect Virtual.

Uneasily, Larionova pointed to the markings on the carapace. They were small triangles, clustered into elaborate patterns. "And what's this stuff?"

Dixon hesitated. "I was afraid you might ask that."

"Well?"

"...We think the markings are artificial, Irina. A deliberate tattoo, carved into the carapace, probably with the mandibles. Writing, maybe: those look like symbolic markings, with information content."

"Lethe," she said.

"I know. This fish was smart," Dixon said.

The people, victorious, clustered around the warmth of their new Chimney. Recovering from their journey and from their battle-wounds, they cruised easily over the gardens of cilia-plants, and browsed on floating fragments of food.

It had been a great triumph. The Heads were dead, or driven off into the labyrinth of tunnels through the Ice. Strong-Flukes had even found the Heads' principal nest here, under the silty floor of the cavern. With sharp stabs of her mandibles, Strong-Flukes had destroyed a dozen or more Head young.

Cilia-of-Gold took herself off, away from the Chimney. She prowled the edge of the Ice cavern, feeding fitfully.

She was a hero. But she couldn't bear the attention of others: their praise, the warmth of their bodies. All she seemed to desire now was the uncomplicated, silent coolness of Ice.

She brooded on the infestation that was spreading through her.

Seekers were a mystery. Nobody knew *why* Seekers compelled their hosts to isolate themselves, to bury themselves in the Ice. What was the point? When the hosts were destroyed, so were the Seekers.

Perhaps it wasn't the Ice itself the Seekers desired, she wondered. Perhaps they sought, in their blind way, something *beyond* the Ice...

But there *was* nothing above the Ice. The caverns were hollows in an infinite, eternal Universe of Ice. Cilia-of-Gold, with a shudder, imagined herself burrowing, chewing her way into the endless Ice, upwards without limit... Was that, finally, how her life would end?

She hated the Seeker within her. She hated her body, for betraying her in this way; and she hated herself.

"Cilia-of-Gold."

She turned, startled, and closed her carapace around herself reflexively.

It was Strong-Flukes and Ice-Born, together. Seeing their warm, familiar bodies, here in this desolate corner of the cavern, Cilia-of-Gold's loneliness welled up inside her, like a Chimney of emotion.

But she swam away from her Three-mates, backwards, her carapace scraping on the cavern's Ice wall.

Ice-Born came towards her, hesitantly. "We're concerned about you."

"Then don't be," she snapped. "Go back to the Chimney, and leave me here."

"No," Strong-Flukes said quietly.

Cilia-of-Gold felt desperate, angry, confined. "You know what's wrong with me, Strong-Flukes. I have a *Seeker*. It's going to kill me. And there's nothing any of us can do about it."

Their bodies pressed close around her now; she longed to open up her carapace to them and bury herself in their warmth.

"We know we're going to lose you, Cilia-of-Gold," Ice-Born said. It sounded as if she could barely speak. Ice-Born had always been the softest, the most loving, of the Three, Cilia-of-Gold thought, the warm heart of their relationship. "And--"

"Yes?"

Strong-Flukes opened her carapace wide. "We want to be Three again," she said.

Already, Cilia-of-Gold saw with a surge of love and excitement, Strong-Flukes's ovipositor was distended: swollen with one of the three isogametes which would fuse to form a new child, their fourth...

A child Cilia-of-Gold could never see growing to consciousness.

"No!" Her cilia pulsed with the single, agonized word.

Suddenly the warmth of her Three-mates was confining, claustrophobic. She had to get away from this prison of

flesh; her mind was filled with visions of the coolness and purity of *Ice*: of clean, high *Ice*.

"Cilia-of-Gold. Wait. Please--"

She flung herself away, along the wall. She came to a tunnel mouth, and she plunged into it, relishing the tunnel's cold, stagnant water.

"Cilia-of-Gold! *Cilia-of-Gold!*"

She hurled her body through the web of tunnels, carelessly colliding with walls of Ice so hard that she could feel her carapace splinter. On and on she swam, until the voices of her Three-mates were lost forever.

*We've dug out a large part of the artifact, Irina, Dolores Wu reported. It's a mass of what looks like hull material.*

"Did you get a sample?"

*No. We don't have anything that could cut through material so dense... Irina, we're looking at something beyond our understanding.*

Larionova sighed. "Just tell me, Dolores," she told Wu's data-desk image.

*Irina, we think we're dealing with the Pauli Principle.*

Pauli's Exclusion Principle stated that no two fermions -- electrons or quarks -- could exist in the same quantum state. Only a certain number of electrons, for example, could share a given energy level in an atom. Adding more electrons caused complex shells of charge to build up around the atom's nucleus. It was the electron shells -- this consequence of Pauli -- that gave the atom its chemical properties.

But the Pauli Principle *didn't* apply to photons; it was possible for many photons to share the same quantum state. That was the essence of the laser: billions of photons, coherent, sharing the same quantum properties.

*Irina, Wu said slowly, what would happen if you could turn off the Exclusion Principle, for a piece of fermionic*

*matter?*

"You can't," Larionova said immediately.

*Of course not. Try to imagine anyway.*

Larionova frowned. What if one could lase mass? "The atomic electron shells would implode, of course."

*Yes.*

"All electrons would fall into their ground state. Chemistry would be impossible."

*Yes. But you may not care...*

"Molecules would collapse. Atoms would fall into each other, releasing immense quantities of binding energy."

*You'd end up with a super dense substance, wouldn't you? Completely non-reactive, chemically. And almost unbreachable, given the huge energies required to detach non-Pauli atoms.*

*Ideal hull material, Irina...*

"But it's all impossible," Larionova said weakly. "You can't violate Pauli."

*Of course you can't,* Dolores Wu replied.

Inside an opaqued bubble-shelter, Larionova, Dixon and Scholes sat on fold-out chairs, cradling coffees.

"If your mercuric was so smart," Larionova said to Dixon, "how come he got himself stuck in the ice?"

Dixon shrugged. "In fact it goes deeper than that. It looked to us as if the mercuric burrowed his way up into the ice, deliberately. What kind of evolutionary advantage could there be in behavior like that? The mercuric was certain to be killed."

"Yes," Larionova said. She massaged her temples, thinking about the mercuric's infection. "But maybe that thread-parasite had something to do with it. I mean, some parasites change the way their hosts behave."

Scholes tapped at a data desk; text and images, reflected from the desk, flickered over his face. "That's

true. There are parasites which transfer themselves from one host to another -- by forcing a primary host to get itself eaten by the second."

Dixon's wide face crumpled. "Lethe. That's disgusting."

"The lancet fluke," Scholes read slowly, "is a parasite of some species of ant. The fluke can make its host climb to the top of a grass stem and then lock onto the stem with its mandibles -- and wait until it's swallowed by a grazing sheep. Then the fluke can go on to infest the sheep in turn."

"Okay," Dixon said. "But why would a parasite force its mercuric host to burrow up into the ice of a frozen ocean? When the host dies, the parasite dies, too. It doesn't make sense."

"There's a lot about this that doesn't make sense," Larionova said. "Like, the whole question of the existence of life in the cavities in the first place. There's no *light* down there. How do the mercurics survive, under two miles of ice?"

Scholes folded one leg on top of the other and scratched his ankle. "I've been going through the data desks." He grimaced, self-deprecating. "A crash course in exotic biology. You want my theory?"

"Go ahead."

"The thermal vents -- which cause the cavities in the first place. The vents are the key. I think the bottom of the Chao ice-cap is like the mid-Atlantic ridge, back on Earth.

"The deep sea, a mile down, is a desert; by the time any particle of food has drifted down from the richer waters above it's passed through so many guts that its energy content is exhausted.

"But along the Ridge, where tectonic plates are colliding, you have hydrothermal vents -- just as at the bottom of Chao. And the heat from the Atlantic vents supports life: in little colonies, strung out along the mid-Atlantic Ridge. The vents form superheated fountains,



smoking with deep-crust minerals which life can exploit: sulphides of copper, zinc, lead and iron, for instance. And there are very steep temperature differences, and so there are high energy gradients -- another prerequisite for life."

"Hmm." Larionova closed her eyes and tried to picture it. *Pockets of warm water, deep in the ice of Mercury; luxuriant mats of life surrounding mineral-rich hydrothermal vents, browsed by Dixon's mercuric animals...* was it possible?

Dixon asked, "How long do the vents persist?"

"On Earth, in the Ridge, a couple of decades. Here we don't know."

"What happens when a vent dies?" Larionova asked. "That's the end of your pocket world, isn't it? The ice chamber would simply freeze up."

"Maybe," Scholes said. "But the vents would occur in rows, along the scarps. Maybe there are corridors of liquid water, within the ice, along which mercurics could migrate."

Larionova thought about that for a while.

"I don't believe it," she said.

"Why not?"

"I don't see how it's possible for life to have *evolved* here in the first place." In the primeval oceans of Earth, there had been complex chemicals, and electrical storms, and...

"Oh, I don't think that's a problem," Scholes said.

She looked at him sharply. Maddeningly, he was grinning again. "Well?" she snapped.

"Look," Scholes said with grating patience, "we've two anomalies on Mercury: the life-forms here at the South Pole, and Dolores Wu's artifact under Caloris. The simplest assumption is that the two anomalies are connected. Let's put the pieces together," he said. "Let's construct a hypothesis..."

Her mandibles ached as she crushed the gritty Ice, carving out her tunnel upwards. The rough walls of the tunnel scraped against her carapace, and she pushed Ice rubble down between her body and her carapace, sacrificing fragile cilia designed to extract soft food particles from warm streams.

The higher she climbed, the harder the Ice became. The Ice was now so cold she was beyond cold; she couldn't even feel the Ice fragments that scraped along her belly and flukes. And, she suspected, the tunnel behind her was no longer open but had refrozen, sealing her here, in this shifting cage, forever. The world she had left -- of caverns, and Chimneys, and children, and her Three-mates -- were remote bubbles of warmth, a distant dream. The only reality was the hard Ice in her mandibles, and the Seeker heavy and questing inside her.

She could feel her strength seeping out with the last of her warmth into the Ice's infinite extent. And yet *still* the Seeker wasn't satisfied; still she had to climb, on and up, into the endless darkness of the Ice.

...But now -- impossibly -- there was something *above* her, breaking through the Ice...

She cowered inside her Ice-prison.

Kevan Scholes said, "Five billion years ago -- when the Solar System was very young, and the crusts of Earth and other inner planets were still subject to bombardment from stray planetesimals -- a ship came here. An interstellar craft, maybe with FTL technology."

"Why? Where from?" Larionova asked.

"I don't know. How could I know that? But the ship must have been massive -- with the bulk of a planetesimal, or more. Certainly highly advanced, with a hull composed of Dolores' super dense Pauli construction material."

"Hmm. Go on."

"Then the ship hit trouble."

"What kind of trouble?"

"I don't *know*. Come on, Dr. Larionova. Maybe it got hit by a planetesimal itself. Anyway, the ship crashed here, on Mercury--"

"Right." Dixon nodded, gazing at Scholes hungrily; the American reminded Larionova of a child enthralled by a story. "It was a disastrous impact. It caused the Caloris feature..."

"Oh, be serious," Larionova said.

Dixon looked at her. "Caloris *was* a pretty unique impact, Irina. Extraordinarily violent, even by the standards of the System's early bombardment phase... Caloris Basin is *eight hundred miles* across; on Earth, its walls would stretch from New York to Chicago."

"So how did anything survive?"

Scholes shrugged. "Maybe the starfarers had some kind of inertial shielding. How can we know? Anyway the ship was wrecked; and the density of the smashed-up hull material caused it to sink into the bulk of the planet, through the Caloris puncture.

"The crew were stranded. So they sought a place to survive. Here, on Mercury."

"I get it," Dixon said. "The only viable environment, long term, was the Chao Meng-Fu ice cap."

Scholes spread his hands. "Maybe the starfarers had to engineer descendants, quite unlike the original crew, to survive in such conditions. And perhaps they had to do a little planetary engineering too; they may have had to initiate some of the hydrothermal vents which created the enclosed liquid-water world down there. And so--"

"Yes?"

"And so the creature we've dug out of the ice is a degenerate descendant of those ancient star travelers, still swimming around the Chao Sea."

Scholes fell silent, his eyes on Larionova.

Larionova stared into her coffee. "A 'degenerate descendant.' After *five billion years*? Look, Scholes, on Earth it's only three and a half billion years since the first prokaryotic cells. And on Earth, whole phyla -- groups of species -- have emerged or declined over periods less than a *tenth* of the time since the Caloris Basin event. Over time intervals like that, the morphology of species flows like hot plastic. So how is it possible for these mercurics to have persisted?"

Scholes looked uncertain. "Maybe they've suffered massive evolutionary changes," he said. "But we're just not recognizing them. For example, maybe the worm parasite is the malevolent descendant of some harmless creature the starfarers brought with them."

Dixon scratched his neck, where the suit-collar ring of dirt was prominent. "Anyway, we've still got the puzzle of the mercuric's burrowing into the ice."

"Hmm." Scholes sipped his cooling coffee. "I've got a theory about that, too."

"I thought you might," Larionova said sourly.

Scholes said, "I wonder if the impulse to climb up to the surface is some kind of residual yearning for the stars."

"*What?*"

Scholes looked embarrassed, but he pressed on: "A racial memory buried deep, prompting the mercurics to seek their lost home world... why not?"

Larionova snorted. "You're a romantic, Kevan Scholes."

A telltale flashed on the surface of the data desk. Dixon leaned over, tapped the telltale and took the call.

He looked up at Larionova, his moonlike face animated. "Irina. They've found another mercuric," he said.

"Is it intact?"

"More than that." Dixon stood and reached for his helmet. "This one isn't dead yet..."

The mercuric lay on Chao's dust-coated ice. Humans stood around it, suited, their face plates anonymously blank.

The mercuric, dying, was a cone of bruised-purple meat a yard long. Shards of shattered transparent carapace had been crushed into its crystallizing flesh. Some of the cilia, within the carapace, stretched and twitched. The cilia looked differently colored to Dixon's reconstruction, as far as Larionova could remember: these were yellowish threads, almost golden.

Dixon spoke quickly to his team, then joined Larionova and Scholes. "We couldn't have saved it. It was in distress as soon as our core broke through into its tunnel. I guess it couldn't take the pressure and temperature differentials. Its internal organs seem to be massively disrupted..."

"Just think." Kevan Scholes stood beside Dixon, his hands clasped behind his back. "There must be millions of these animals in the ice under our feet, embedded in their pointless little chambers. Surely none of them could dig more than a hundred yards or so up from the liquid layer."

Larionova switched their voices out of her consciousness. She knelt down, on the ice; under her knees she could feel the criss-cross heating elements in her suit's fabric.

She peered into the dulling sonar-eyes of the mercuric. The creature's mandibles -- prominent and sharp -- opened and closed, in vacuum silence.

She felt an impulse to reach out her gloved hand to the battered flank of the creature: to *touch* this animal, this person, whose species had, perhaps, traveled across light years -- and five billion years -- to reach her...

But still, she had the nagging feeling that something was wrong with Scholes' neat hypothesis. The mercuric's physical design seemed crude. Could this really have been a starfaring species? The builders of the ship in Caloris

must have had some form of major tool-wielding capability. And Dixon's earlier study had shown that the creature had no trace of any limbs, even vestigially...

*Vestigial limbs*, she remembered. *Lethe*.

Abruptly her perception of this animal -- and its host parasite -- began to shift; she could feel a paradigm dissolving inside her, melting like a Mercury snowflake in the Sun.

"Dr. Larionova? Are you all right?"

Larionova looked up at Scholes. "Kevan, I called you a romantic. But I think you were almost correct, after all. *But not quite*. Remember we've suggested that the *parasite* -- the infestation -- changes the mercuric's behavior, causing it to make its climb."

"What are you saying?"

Suddenly, Larionova saw it all. "I don't believe this mercuric is descended from the starfarers -- the builders of the ship in Caloris. I think the rise of the mercurics' intelligence was a *later* development; the mercurics grew to consciousness *here*, on Mercury. I *do* think the mercurics are descended from something that came to Mercury on that ship, though. A pet, or a food animal -- Lethe, even some equivalent of a stomach bacteria. Five billion years is time enough for anything. And, given the competition for space near the short-lived vents, there's plenty of encouragement for the development of intelligence, down inside this frozen sea."

"And the starfarers themselves?" Scholes asked. "What became of them? Did they die?"

"No," she said. "No, I don't think so. But they, too, suffered huge evolutionary changes. I think they did devolve, Scholes; in fact, I think they lost their awareness."

"But one thing persisted within them, across all this desert of time. And that was the starfarers' vestigial will to *return* -- to the surface, one day, and at last to the stars..."

It was a will which had survived even the loss of consciousness itself, somewhere in the long, stranded aeons: a relic of awareness long since transmuted to a deeper biochemical urge -- *a will to return home*, still embedded within a once-intelligent species reduced by time to a mere parasitic infection.

But it was a home which, surely, could no longer exist.

The mercuric's golden cilia twitched once more, in a great wave of motion which shuddered down its ice-flecked body.

Then it was still.

Larionova stood up; her knees and calves were stiff and cold, despite the suit's heater. "Come on," she said to Scholes and Dixon. "You'd better get your team off the ice as soon as possible; I'll bet the universities have their first exploratory teams down here half a day after we pass Earth the news."

Dixon nodded. "And Thoth?"

"Thoth? I'll call Superet. I guess I've an asteroid to order..."

*And then she thought, at last I can sleep. Sleep and get back to work.*

With Scholes and Dixon, she trudged across the dust-strewn ice to the bubble-shelters.

She could feel the Ice under her belly... but above her *there was no Ice*, no water even, an infinite *nothing* into which the desperate pulses of her blinded eyes disappeared without echo.

Astonishingly -- impossibly -- she *was*, after all, above the Ice. How could this be? Was she in some immense upper cavern, its Ice roof too remote to see? Was this the nature of the Universe, a hierarchy of caverns within caverns?

She knew she would never understand. But it didn't seem to matter. And, as her awareness faded, she felt the Seeker inside her subside to peace.

A final warmth spread out within her. Consciousness splintered like melting ice, flowing away through the closing tunnels of her memory.

*"At last," Eve told me, "the Thoth Sun probe hardware was ready. Now, all that was needed was the software..."*



# Lieserl

**A.D. 3951**

Lieserl was suspended inside the body of the Sun.

She spread her arms wide and lifted up her face. She was deep within the Sun's convective zone, the broad mantle of turbulent material beneath the glowing photosphere; convective cells larger than the Earth, tangled with ropes of magnetic flux, filled the world around her. She could hear the roar of the great convective founts, smell the stale photons diffusing out towards space from the remote fusing core.

She felt as if she were inside some huge cavern. Looking up she could see how the photosphere formed a glowing roof over her world perhaps fifty thousand miles above her, and the boundary of the inner radiative zone was a shining, impenetrable floor another fifty thousand miles beneath.

*Lieserl? Can you hear me? Are you all right?*

Kevan Scholes. It sounded like her mother's voice, she thought.

She thrust her arms down by her sides and swooped up, letting the floor and roof of the cavern-world wheel around her. She opened up her senses, so that she could feel the turbulence as a whisper against her skin, the glow of hard photons from the core as a gentle warmth against her face.

*Lieserl? Lieserl?*

She remembered how her mother had enfolded her in her arms. "The Sun, Lieserl. *The Sun...*"

Even at the moment she was born she knew something was wrong.

A face loomed over her: wide, smooth, smiling. The cheeks were damp, the glistening eyes huge. "Lieserl. Oh, Lieserl..."

*Lieserl. My name, then.*

She explored the face before her, studying the lines around the eyes, the humorous upturn of the mouth, the strong nose. It was an intelligent, lived-in face. *This is a good human being*, he thought. *Good stock...*

*Good stock? What am I thinking of?*

This was impossible. She felt terrified of her own explosive consciousness. She shouldn't even be able to focus her eyes yet...

She tried to touch her mother's face. Her own hand was still moist with amniotic fluid -- *but it was growing visibly*, the bones extending and broadening, filling out the loose skin like a glove.

She opened her mouth. It was dry, her gums already sore with budding teeth.

She tried to speak.

Her mother's eyes brimmed with tears. "Oh, Lieserl. My impossible baby."

Strong arms reached beneath her. She felt weak, helpless, consumed by growth. Her mother lifted her up, high in the air. Bony adult fingers dug into the aching flesh of her back; her head lolled backwards, the expanding muscles still too weak to support the burgeoning weight of her head. She could sense other adults surrounding her, the bed in which she'd been born, the outlines of a room.

She was held before a window, with her body tipped forward. Her head lolled; spittle laced across her chin.

An immense light flooded her eyes.

She cried out.

Her mother enfolded her in her arms. "The Sun, Lieserl. *The Sun...*"

The first few days were the worst. Her parents -- impossibly tall, looming figures -- took her through brightly lit rooms, a garden always flooded with sunlight. She learned to sit up. The muscles in her back fanned out, pulsing as they grew. To distract her from the unending pain, clowns tumbled over the grass before her, chortling through their huge red lips, then popping out of existence in clouds of pixels.

She grew explosively, feeding all the time, a million impressions crowding into her soft sensorium.

There seemed to be no limit to the number of rooms in this place, this House. Slowly she began to understand that some of the rooms were Virtual chambers -- blank screens against which any number of images could be projected. But even so, the House must comprise hundreds of rooms. And she -- with her parents -- wasn't alone here, she slowly realized. There were other people, but at first they kept away, out of sight, apparent only by their actions: the meals they prepared, the toys they left her.

On the third day her parents took her on a trip by flitter. It was the first time she'd been away from the House, its grounds. She stared through the bulbous windows, pressing her nose to heated glass. The journey was an arc over a toy-like landscape; a breast of blue ocean curved away from the land, all around her. This was the island of Skiros, her mother told her, and the sea was called the Aegean. The House was the largest construct on the island; it was a jumble of white, cubeshaped buildings, linked by corridors and surrounded by garden -- grass, trees. Further out there were bridges and roads looping through the air above the ground, houses like a child's bricks sprinkled across glowing hillsides.

Everything was drenched in heavy, liquid sunlight.

The flitter snuggled at last against a grassy sward close to the shore of an ocean. Lieserl's mother lifted her out and

placed her -- on her stretching, unsteady legs -- on the rough, sandy grass.

Hand in hand, the little family walked down a short slope to the beach.

The Sun burned through thinned air from an unbearably blue sky. Her vision seemed telescopic. She looked at distant groups of children and adults playing -- far away, halfway to the horizon -- and it was as if she was among them herself. Her feet, still uncertain, pressed into gritty, moist sand. She could taste the brine salt on the air; it seemed to permeate her very skin.

She found mussels clinging to a ruined pier. She prised them away with a toy spade, and gazed, fascinated, at their slime-dripping feet.

She sat on the sand with her parents, feeling her light costume stretch over her still-growing limbs. They played a simple game, of counters moving over a floating Virtual board, pictures of ladders and hissing snakes. There was laughter, mock complaints by her father, elaborate pantomimes of cheating.

Her senses were electric. It was a wonderful day, full of light and joy, extraordinarily vivid sensations. Her parents loved her -- she could see that in the way they moved with each other, came to her, played with her.

They must know she was different; but they didn't seem to care.

She didn't want to be different -- to be *wrong*. She closed her mind against the thoughts, and concentrated on the snakes, the ladders, the sparkling counters.

Every morning she woke up in a bed that felt too small.

Lieserl liked the garden. She liked to watch the flowers straining their tiny, pretty faces towards the Sun, as the great light climbed patiently across the sky. The sunlight made the flowers grow, her father told her. Maybe she was

like a flower, she thought, growing too quickly in all this sunlight.

On the fifth day she was taken to a wide, irregularly shaped, colorful classroom. This room was full of children -- *other children!* -- and toys, drawings, books. Sunlight flooded the room; perhaps there was some clear dome stretched over the open walls.

The children sat on the floor and played with paints and dolls, or talked earnestly to brilliantly-colored Virtual figures -- smiling birds, tiny clowns. The children turned to watch as she came in with her mother, their faces round and bright, like dapples of sunlight through leaves. She'd never been so close to other children before. Were these children *different*, too?

One small girl scowled at her, and Lieserl quailed against her mother's legs. But her mother's familiar warm hands pressed into her back. "Go ahead. It's all right."

As she stared at the unknown girl's scowling face, Lieserl's questions, her too-adult, too-sophisticated doubts, seemed to evaporate. Suddenly, all that mattered to her -- all that mattered in the world -- was that she should be accepted by these children -- that they wouldn't know she was *different*.

An adult approached her: a man, young, thin, his features bland with youth. He wore a jumpsuit colored a ludicrous orange; in the sunlight, the glow of it shone up over his chin. He smiled at her. "Lieserl, isn't it? My name's Michael. We're glad you're here." In a louder, exaggerated voice, he said, "Aren't we, people?"

He was answered by a rehearsed, chorused "Yes."

"Now come and we'll find something for you to do," Michael said. He led her across the child-littered floor to a space beside a small boy. The boy -- red-haired, with startling blue eyes -- was staring at a Virtual puppet which endlessly formed and reformed: the figure two, collapsing

into two snowflakes, two swans, two dancing children; the figure three, followed by three bears, three fish swimming in the air, three cakes. The boy mouthed the numbers, following the tinny voice of the Virtual. "Two. One. Two and one is three."

Michael introduced her to the boy -- Tommy -- and she sat down with him. Tommy, she was relieved to find, was so fascinated by his Virtual that he scarcely seemed aware that Lieserl was present -- let alone *different*.

The number Virtual ran through its cycle and winked out of existence. "Bye-bye, Tommy! Goodbye, Lieserl!"

Tommy was resting on his stomach, his chin cupped in his palms. Lieserl, awkwardly, copied his posture. Now Tommy turned to her -- without appraisal, merely looking at her, with unconscious acceptance.

Lieserl said, "Can we see it again?"

He yawned and poked a finger into one nostril. "No. Let's see another. There's a great one about the pre-Cambrian explosion--"

"The what?"

He waved a hand dismissively. "You know, the Burgess Shale and all that. Wait till you see *Hallucigenia* crawling over your neck..."

The children played, and learned, and napped. Later, the girl who'd scowled at Lieserl -- Ginnie -- started some trouble. She poked fun at the way Lieserl's bony wrists stuck out of her sleeves (Lieserl's growth rate was slowing, but she was still growing out of her clothes during a day). Then -- unexpectedly, astonishingly -- Ginnie started to bawl, claiming that Lieserl had walked through her Virtual. When Michael came over Lieserl started to explain, calmly and rationally, that Ginnie must be mistaken; but Michael told her not to cause such distress, and for punishment she was forced to sit away from the other children for ten minutes, without stimulation.

It was all desperately, savagely unfair. It was the longest ten minutes of Lieserl's life. She glowered at Ginnie, filled with resentment.

The next day she found herself looking forward to going to the room with the children again. She set off with her mother through sunlit corridors. They reached the room Lieserl remembered -- there was Michael, smiling a little wistfully to her, and Tommy, and the girl Ginnie -- but Ginnie seemed different: childlike, unformed...

At least a head shorter than Lieserl.

Lieserl tried to recapture that delicious enmity of the day before, but it vanished even as she conjured it. Ginnie was just a kid.

She felt as if something had been stolen from her.

Her mother squeezed her hand. "Come on. Let's find a new room for you to play in."

Every day was unique. Every day Lieserl spent in a new place, with new people.

The world glowed with sunlight. Shining points trailed endlessly across the sky: low-orbit habitats and comet nuclei, tethered for power and fuel. People walked through a sea of information, with access to the Virtual libraries available anywhere in the world, at a subvocalized command. Lieserl learned quickly. She read about her parents. They were scientists, studying the Sun. They weren't alone; there were many people, huge resources, devoted to the Sun.

In the libraries there was a lot of material about the Sun, little of which she could follow. But she sensed some common threads.

Once, people had taken the Sun for granted. No longer. Now -- for some reason -- they *feared* it.

On the ninth day Lieserl studied herself in a Virtual holomirror. She had the image turn around, so she could see the shape of her skull, the lie of her hair. There was

still some childish softness in her face, she thought, but the woman inside her was emerging already, as if her childhood was a receding tide. She would look like her mother -- Phillida -- in the strong-nosed set of her face, her large, vulnerable eyes; but she would have the sandy coloring of her father, George.

Lieserl looked about nine years old. But she was just nine *days* old.

She bade the Virtual break up; it shattered into a million tiny images of her face which drifted away like flies in the sunlit air.

Phillida and George were fine parents, she thought. They spent their time away from her working through technical papers -- which scrolled through the air like falling leaves -- and exploring elaborate, onion-ring Virtual models of stars. Although they were both clearly busy they gave themselves to her without hesitation. She moved in a happy world of smiles, sympathy and support.

Her parents loved her unreservedly. But that wasn't always enough.

She started to come up with more complicated, detailed questions. Like, what was the mechanism by which she was growing so rapidly? She didn't seem to eat more than the other children she encountered; what could be fueling her absurd growth rates?

How did she *know* so much? She'd been born self-aware, with even the rudiments of language in her head. The Virtuals she interacted with in the classrooms were fun, and she always seemed to learn something new; but she absorbed no more than scraps of knowledge through them compared to the feast of insight with which she awoke each morning.

What had taught her, in the womb? What was teaching her now?



She had no answers. But perhaps -- somehow -- it was all connected with this strange, global obsession with the Sun. She remembered her childish fantasy -- that she might be like a flower, straining up too quickly to the Sun. Maybe, she wondered now, there was some grain of truth in that insight.

The strange little family had worked up some simple, homely rituals together. Lieserl's favorite was the game, each evening, of snakes and ladders. George brought home an old set -- a *real* board made of card, and wooden counters. Already Lieserl was too old for the game; but she loved the company of her parents, her father's elaborate jokes, the simple challenge of the game, the feel of the worn, antique counters.

Phillida showed her how to use Virtuals to produce her own game boards. Her first efforts, on her eleventh day, were plain, neat forms, little more than copies of the commercial boards she'd seen. But soon she began to experiment. She drew a huge board of a million squares, which covered a whole room -- she could walk through the board, a planar sheet of light at about waist-height. She crammed the board with intricate, curling snakes, vast ladders, vibrantly glowing squares -- detail piled on detail.

The next morning she walked with eagerness to the room where she'd built her board -- and was immediately disappointed. Her efforts seemed pale, static, derivative -- obviously the work of a child, despite the assistance of the Virtual software.

She wiped the board clean, leaving a grid of pale squares floating in the air. Then she started to populate it again -- but this time with animated half-human snakes, slithering "ladders" of a hundred forms. She'd learned to access the Virtual libraries, and she plundered the art and history of a hundred centuries to populate her board.

Of course it was no longer possible to play games on the board, but that didn't matter. The board was the thing, a little world in itself. She withdrew a little from her parents, spending long hours in deep searches through the libraries. She gave up her classes. Her parents didn't seem to mind; they came to speak to her regularly, and showed an interest in her projects, and respected her privacy.

The board kept her interest the next day. But now she evolved elaborate games, dividing the board into countries and empires with arbitrary bands of glowing light. Armies of ladder-folk joined with legions of snakes in crude reproductions of the great events of human history.

She watched the symbols flicker across the Virtual board, shimmering, coalescing; she dictated lengthy chronicles of the histories of her imaginary countries.

By the end of the day, though, she was starting to grow more interested in the history texts she was plundering than in her own elaborations on them. She went to bed, eager for the next morning to come.

She awoke in darkness, doubled in agony.

She called for light, which flooded the room, sourceless. She sat up in bed.

Blood spotted the sheets. She screamed.

Phillida sat with her, cradling her head. Lieserl pressed herself against her mother's warmth, trying to still her trembling.

"I think it's time you asked me your questions."

Lieserl sniffed. "What questions?"

"The ones you've carried around with you since the moment you were born." Phillida smiled. "I could see it in your eyes, even at that moment. You poor thing... to be burdened with so much *awareness*. I'm sorry, Lieserl."

Lieserl pulled away. Suddenly she felt cold, vulnerable.

"Tell me why you're sorry," she said at last.

"You're my daughter." Phillida placed her hands on Lieserl's shoulders and pushed her face close; Lieserl could feel the warmth of her breath, and the soft room light caught the gray in her mother's blonde hair, making it seem to shine. "Never forget that. You're as human as I am. But--" She hesitated.

"But what?"

"But you're being -- *engineered*."

Nanobots swarmed through Lieserl's body, Phillida said. They plated calcium over her bones, stimulated the generation of new cells, force-growing her body like some absurd human sunflower -- they even implanted memories, artificial learning, directly into her cortex.

Lieserl felt like scraping at her skin, gouging out this artificial infection. "*Why?* Why did you let this be done to me?"

Phillida pulled her close, but Lieserl stayed stiff, resisting mutely. Phillida buried her face in Lieserl's hair; Lieserl felt the soft weight of her mother's cheek on the crown of her head. "Not yet," Phillida said. "Not yet. A few more days, my love. That's all..."

Phillida's cheeks grew warmer, as if she was crying, silently, into her daughter's hair.

Lieserl returned to her snakes-and-ladders board. She found herself looking on her creation with affection, but also nostalgic sadness; she felt distant from this elaborate, slightly obsessive concoction.

Already she'd outgrown it.

She walked into the middle of the sparkling board and bade a Sun, a foot wide, rise out from the center of her body. Light swamped the board, shattering it.

She wasn't the only adolescent who had constructed fantasy worlds like this. She read about the Brontes, in their lonely parsonage in the north of England, and their elaborate shared world of kings and princes and empires.

And she read about the history of the humble game of snakes and ladders. The game had come from India, where it was a morality teaching aid called *Moksha-Patamu*. There were twelve vices and four virtues, and the objective was to get to Nirvana. It was easier to fail than to succeed... The British in the nineteenth century had adopted it as an instructional guide for children called *Kismet*; Lieserl stared at images of claustrophobic boards, forbidding snakes. Thirteen snakes and eight ladders showed children that if they were good and obedient their life would be rewarded.

But by a few decades later the game had lost its moral subtexts. Lieserl found images from the early twentieth century of a sad-looking little clown; he slithered haplessly down snakes and heroically clambered up ladders. Lieserl stared at him, trying to understand the appeal of his baggy trousers, walking cane and little moustache.

The game, with its charm and simplicity, had survived through the twenty centuries which had worn away since the death of that forgotten clown.

She grew interested in the *numbers* embedded in the various versions of the game. The twelve-to-four ratio of *Moksha-Patamu* clearly made it a harder game to win than *Kismet's* thirteen-to-eight -- but how much harder?

She began to draw new boards in the air. But these boards were abstractions -- clean, colorless, little more than sketches. She ran through high-speed simulated games, studying their outcomes. She experimented with ratios of snakes to ladders, with their placement. Phillida sat with her and introduced her to combinatorial mathematics, the theory of games -- to different forms of wonder.

On her fifteenth day she tired of her own company and started to attend classes again. She found the perceptions

of others a refreshing counterpoint to her own, high-speed learning.

The world seemed to open up around her like a flower; it was a world full of sunlight, of endless avenues of information, of stimulating people.

She read up on nanobots.

Body cells were programed to commit suicide. A cell itself manufactured enzymes which cut its DNA into neat pieces, and quietly closed down. The suicide of cells was a guard against uncontrolled growth -- tumors -- and a tool to sculpt the developing body: in the womb, the withering of unwanted cells carved fingers and toes from blunt tissue buds. Death was the default state of a cell. Chemical signals were sent by the body, to instruct cells to remain alive.

The nanotechnological manipulation of this process made immortality simple.

It also made the manufacture of a Lieserl simple.

Lieserl studied this, scratching absently at her inhabited, engineered arms. She still didn't know *why*.

With a boy called Matthew, from her class, she took a trip away from the House -- without her parents for the first time. They rode a flitter to the shore where she'd played as a child, twelve days earlier. She found the broken pier where she'd discovered mussels. The place seemed less vivid -- less magical -- and she felt a sad nostalgia for the loss of the freshness of her childish senses.

But there were other compensations. Her body was strong, lithe, and the sunlight was like warm oil on her skin. She ran and swam, relishing the sparkle of the ozone-laden air in her lungs. She and Matthew mock-wrestled and chased in the surf, clambering over each other like young apes -- like children, she thought, but not quite with complete innocence...

As sunset approached they allowed the flitter to return them to the House. They agreed to meet the next day, perhaps take another trip somewhere. Matthew kissed her lightly, on the lips, as they parted.

That night she could barely sleep. She lay in the dark of her room, the scent of salt still strong in her nostrils, the image of Matthew alive in her mind. Her body seemed to pulse with hot blood, with its endless, continuing growth.

The next day -- her sixteenth -- Lieserl rose quickly. She'd never felt so alive; her skin still glowed from the salt and sunlight of the shore, and there was a hot tension inside her, an ache deep in her belly, a tightness.

When she reached the flitter bay at the front of the House, Matthew was waiting for her. His back was turned, the low sunlight causing the fine hairs at the base of his neck to glow.

He turned to face her.

He reached out to her, uncertainly, then allowed his hands to drop to his sides. He didn't seem to know what to say; his posture changed, subtly, his shoulders slumping slightly; before her eyes he was becoming shy of her.

She was taller than him. Visibly *older*. She became abruptly aware of the still-childlike roundness of his face, the awkwardness of his manner. The thought of *touching* him -- the memory of her feverish dreams during the night - - seemed absurd, impossibly adolescent.

She felt the muscles in her neck tighten; she felt as if she must scream. Matthew seemed to recede from her, as if she was viewing him through a tunnel.

Once again the laboring nanobots -- the damned, unceasing nanotechnological infection of her body -- had taken away part of her life.

This time, though, it was too much to bear.

"*Why? Why?*" She wanted to scream abuse at her mother -- to *hurt* her.

Phillida had never looked so old. Her skin seemed drawn tight across the bones of her face, the lines etched deep. "I'm sorry," she said. "Believe me. When we -- George and I -- volunteered for this program, we knew it would be painful. But we never dreamed how much. Neither of us had had children before. Perhaps if we had, we'd have been able to anticipate how this would feel."

"I'm a freak -- an absurd experiment," Lieserl shouted. "A *construct*. Why did you make me human? Why not some insentient animal? Why not a Virtual?"

"Oh, you had to be human. As human as possible..." Phillida seemed to come to a decision. "I'd hoped to give you a few more days of -- life, normality -- before it had to end. You seemed to be finding some happiness--"

"In fragments," Lieserl said bitterly. "This is no life, Phillida. It's *grotesque*."

"I know. I'm sorry, my love. Come with me."

"Where?"

"Outside. To the garden. I want to show you something."

Suspicious, hostile, Lieserl allowed her mother to take her hand; but she made her fingers lie lifeless, cold in Phillida's warm grasp.

It was mid-morning now. The Sun's light flooded the garden; flowers -- white and yellow -- strained up towards the sky.

Lieserl looked around; the garden was empty. "What am I supposed to be seeing?"

Phillida, solemnly, pointed upwards.

Lieserl tilted back her head, shading her eyes to block out the light. The sky was a searing-blue dome, marked only by a high vapor trail and the lights of habitats.

"No." Gently, Phillida pulled Lieserl's hand down from her face, and, cupping her chin, tipped her face flowerlike towards the Sun.

The star's light seemed to fill her head. Dazzled, she dropped her eyes, stared at Phillida through a haze of blurred, streaked retinal images.

The Sun. Of course...

Kevan Scholes said, *Damn it, Lieserl, you're going to have to respond properly. Things are difficult enough without--*"

I know. I'm sorry. How are you feeling, anyway?"

*Me? I'm fine. But that's hardly the point, is it? Now come on, Lieserl, the team here are getting on my back; let's run through the tests.*

"You mean I'm not down here to enjoy myself?"

Scholes, speaking from his safe habitat far beyond the photosphere, didn't respond.

"Yeah. The tests. Okay, electromagnetic first." She adjusted her sensorium. "I'm plunged into darkness," she said drily. "There's very little free radiation at any frequency -- perhaps an X-ray glow from the photosphere; it looks a little like a late evening sky. And--"

*We know the systems are functioning. I need to know what you see, what you feel.*

"What I feel?"

She spread her arms and sailed backwards through the "air" of the cavern. The huge convective cells buffeted and merged like living things, whales in this insubstantial sea of gas.

"I see convection fountains," she said. "A cave full of them."

She rolled over onto her belly, so that she was gliding face down, surveying the plasma sea below her. She *opened* her eyes, changing her mode of perception. The convective honeycomb faded into the background of her senses, and the magnetic flux tubes came into prominence, solidifying out of the air; beyond them the convective



pattern was a sketchy framework, overlaid. The tubes were each a hundred yards broad, channels cutting through the air; they were thousands of miles long, and they filled the air around her, all the way down to the plasma sea.

Lieserl dipped into a tube; she felt the tingle of enhanced magnetic strength. Its walls rushed past her, curving gracefully. "It's wonderful," she said. "I'm inside a flux tube. It's an immense tunnel; it's like a fairground ride. I could follow this path all the way round the Sun."

*Maybe. I don't know if we need the poetry, Lieserl.* Kevan Scholes hesitated, and when he spoke again he sounded severely encouraging, as if he'd been instructed to be nice to her. *We're glad you're feeling -- ah -- happy in yourself, Lieserl.*

"My new self. Maybe. Well, it was an improvement on the old; you have to admit that."

*Yes. I want you to think back to the downloading. Can you do that?*

"The downloading? Why?"

*Come on, Lieserl. It's another test, obviously.*

"A test of what?"

*Your trace functions. We want to know if --*

"My trace functions. You mean my memory."

*...Yes. He had the grace to sound embarrassed. Think back, Lieserl. Can you remember?*

*Downloading...*

It was her ninetieth day, her ninetieth physical-year. She was impossibly frail -- unable even to walk, or feed herself, or clean herself.

They'd taken her to a habitat close to the Sun. They'd almost left the download too late; they'd had one scare when an infection had somehow got through to her and settled into her lungs, nearly killing her.

She wanted to die.

Physically she was the oldest human in the System. She felt as if she were underwater: she could barely feel, or taste, or see anything, as if she was encased in some deadening, viscous fluid. And she knew her mind was failing.

It was so fast she could *feel* it. It was like a ghastly reverse run of her accelerated childhood. She woke every day to a new diminution of her self. She had come to dread sleep, yet could not avoid it.

She couldn't bear the indignity of it. Everybody else was immortal, and young; and the AS technology which had made them so was being used to kill Lieserl. She hated those who had put her in this position.

Her mother visited her for the last time, a few days before the download. Lieserl, through her ruined, rheumy old eyes, was barely able to recognize Phillida -- this young, weeping woman, only a few months older than when she had held up her baby girl to the Sun.

Lieserl cursed her, sent her away.

At last she was taken, in her bed, to a downloading chamber at the heart of the habitat.

*Do you remember, Lieserl? Was it -- continuous?*

"...No."

It was a sensory explosion.

In an instant she was young again, with every sense alive and vivid. Her vision was sharp, her hearing impossibly precise. And slowly, slowly, she had become aware of new senses -- senses beyond the human. She could see the dull infra-red glow of the bellies and heads of the people working around the shell of her own abandoned body, the sparkle of X-ray photons from the Solar photosphere as they leaked through the habitat's shielding.

She'd retained her human memories, but they were qualitatively different from the experiences she was

accumulating now. Limited, partial, subjective, imperfectly recorded: like fading paintings, she thought.

...Except, perhaps, for that single, golden, day at the beach.

She studied the husk of her body. It was almost visibly imploding now, empty...

"I remember," she told Kevan Scholes. "Yes, I remember."

Now the flux tube curved away to the right; and, in following it, she became aware that she was tracing out a spiral path. She let herself relax into the motion, and watched the cave-world beyond the tube wheel around her. The flux tubes neighboring her own had become twisted into spirals too, she realized; she was following one strand in a rope of twisted-together flux tubes.

*Lieserl, what's happening? We can see your trajectory's altering, fast.*

"I'm fine. I've got myself into a flux rope, that's all..."

*Lieserl, you should get out of there...*

She let the tube sweep her around. "Why? This is fun."

*Maybe. But it isn't a good idea for you to break the surface; we're concerned about the stability of the wormhole --*

Lieserl sighed and let herself slow. "Oh, damn it, you're just no fun. I would have enjoyed bursting out through the middle of a sunspot. What a great way to go."

*We're not done with the tests yet, Lieserl.*

"What do you want me to do?"

*One more...*

"Just tell me."

*Run a full self-check, Lieserl. Just for a few minutes... drop the Virtual constructs.*

She hesitated. "Why? The systems are obviously functioning to specification."

*Lieserl, you don't need to make this difficult for me.* Scholes sounded defensive. *This is a standard suite of tests for any AI which --*

"All right, damn it."

She closed her eyes, and with a sudden, impulsive stab of will, let her Virtual image of herself -- the illusion of a human body around her -- crumble.

It was like waking from a dream: a soft, comfortable dream of childhood, waking to find herself entombed in a machine, a crude construct of bolts and cords and gears.

She considered herself.

The tetrahedral Interface of the wormhole was suspended in the body of the Sun. The thin, searing-hot gas of the convective zone poured into its four triangular faces, so that the Interface was surrounded by a sculpture of inflowing gas, a flower carved dynamically from the Sun's flesh, almost obscuring the Interface itself. The Solar material was, she knew, being pumped through the wormhole to the second Interface in orbit around the Sun; convection zone gases emerged, blazing, from the drifting tetrahedron, making it into a second, miniature Sun around which human habitats could cluster.

By pumping away the gas, and the heat it carried, the Interface refrigerated itself, enabling it to survive -- with its precious, fragile cargo of datastores...

The stores which sustained the awareness of herself, Lieserl.

She inspected herself, at many levels, simultaneously.

At the physical level she studied crisp matrices of data, shifting, coalescing. And overlaid on that was the logical structure of data storage and access paths which represented the components of her mind.

*Good... good, Lieserl. You're sending us good data. How are you feeling?*

"You keep asking me that, damn it. I feel--"

Enhanced...

No longer trapped in a single point, in a box of bone behind eyes made of jelly.

What made her conscious? It was the ability to be aware of what was happening in her mind, and in the world around her, and what had happened in the past.

By any test, she was more conscious than any other human -- because she had more of the *machinery* of consciousness.

She was supremely conscious -- the most conscious human who had ever lived.

If, she thought uneasily, she was still human.

*Good. Good. All right, Lieserl. We have work to do.*

She let her awareness implode, once more, into a Virtual-human form. Her perception was immediately simplified. To be seeing through apparently human eyes was comforting... and yet, she thought, restrictive.

Perhaps it wouldn't be much longer before she felt ready to abandon even this last vestige of humanity. And then what?

*Lieserl?*

"I hear you."

She turned her face towards the core.

"There is a *purpose*, Lieserl," her mother said. "A justification. You aren't simply an experiment. You have a mission." She waved her hand at the sprawling, friendly buildings that comprised the House. "Most of the people here, particularly the children, don't know anything about you. They have jobs, goals -- lives of their own to follow. But they're here for *you*."

"Lieserl, your experiences have been designed -- George and I were selected, even -- to ensure that the first few days of your existence would *imprint* you with humanity."

"The first few days?" Suddenly the unknowable future was like a black wall, looming towards her; she felt as out of control of her life as if she was a counter on some immense, invisible chutes-and-ladders board.

"I don't want this. I want to be me. I want my freedom, Phillida."

"No, Lieserl. You're not free, I'm afraid; you never can be. You have a goal."

"What goal?"

"Listen to me. The Sun gave us life. Without it -- without the other stars -- we couldn't survive."

"We're a strong species. We believe we can live as long as the stars -- for tens of billions of years. And perhaps even beyond that. But we've had -- glimpses -- of the future, the far distant future... disturbing glimpses. People are starting to plan for that future -- to work on projects which will take millions of years to come to fruition..."

"Lieserl, you're one of those projects."

"I don't understand."

Phillida took her hand, squeezed it gently; the simple human contact seemed incongruous, the garden around them transient, a chimera, before this talk of megayears and the future of the species.

"Lieserl, something is wrong with the Sun. *You* have to find out what. The Sun is dying; something -- or someone -- is *killing* it."

Phillida's eyes were huge before her, staring, probing for understanding. "Don't be afraid. My dear, you will live forever. If you want to. You are a new form of human. And you will see wonders of which I -- and everyone else who has ever lived -- can only dream."

Lieserl listened to her tone, coldly, analyzing it. "But you don't *envy* me. Do you, Phillida?"

Phillida's smile crumbled. "No," she said quietly.

Lieserl tipped back her head. An immense light flooded her eyes.

She cried out.

Her mother enfolded her in her arms. "The Sun, Lieserl. The Sun..."

*The woman Lieserl -- engineered, distorted, unhappy -- receded from my view, her story incomplete.*<sup>[4]</sup>

*Humans diffused out beyond the Solar System in their bulky, ponderous slower-than-light GUTships. In the increasing fragmentation of mankind, the shock of the Poole wormhole incursion faded -- despite the ominous warnings of Superet -- and it remained a time of optimism, of hope, of expansion into an unlimited future.*

*Then the first extra-Solar intelligence was encountered, somewhere among the stars.*

*Squeem ships burst into the System, in a shower of exotic particles and lurid publicity. Communication with the Squeem was utterly unlike anything envisaged before their arrival. The Squeem didn't count, for instance. But eventually common ground was found.*

*The Squeem were aquatic group-mind multiple creatures. They crossed the stars using a hyperdrive system, which was beyond human understanding. They maintained an interstellar network of trading colonies.*

*The Squeem seemed friendly enough. Trade and cultural contacts were initiated.*

*And then, in orbit around every inhabited world in the Solar System, hyperdrive cannon-platforms appeared...*

## **PART 2**

### **ERA: Squeem Occupation**



## Pilot

**A.D. 4874**

When the Squeem occupation laws were announced, Anna Gage was halfway through a year-long journey into Jove from Port Sol. She paged through the news channels, appalled.

Human space travel was suspended. Wherever the great GUTship interplanetary freighters landed they were being broken up. The Poole wormhole fast-transit routes were collapsed. Humans were put to work on Squeem projects.

Resistance had imploded quickly.

Anna Gage -- shocked, alone, stranded between worlds -- tried to figure out what to do.

She was seventy-nine years old, thirty-eight physical. She was a GUTship pilot; for ten years she'd carried bulk cargo from the inner worlds to the new colonies clustered around Port Sol in the Kuiper Belt.

Since she operated her ship on minimum overheads, her supplies were limited. She couldn't stay out here for long. But she couldn't return to an occupied Earth and let herself be grounded. She was psychologically incapable of that.

Still outside the orbit of Saturn, she dumped her freight and began a long deceleration.

She began probing the sky with message lasers. There had to be others out here, others like her, stranded above the occupied lands.

After a few days, with the Sun still little more than a spark ahead of her, she got a reply.

*Chiron...*

She opened up her GUTdrive and skimmed around the orbit of Saturn.

Chiron was an obscure ice dwarf, a dirty snowball two hundred miles across. It looped between the orbits of Saturn and Uranus, following a highly elliptical orbit. One day the gravitational fields of the gas giants would hurl it out of the System altogether.

It had never been very interesting.

When Gage approached Chiron, she found a dozen GUTships drifting like spent matches around the limbs of the worldlet. The ships looked as if they were being dismantled, their components being hauled down into the interior of the worldlet.

A Virtual -- of a man's head -- rustled into existence in the middle of Gage's cabin. The disembodied head eyed Gage in her pilot's cocoon. The jostling pixels of his head enlarged, as if engorging with blood; Gage imagined data leaking down to the worldlet's surface.

"I'm Moro. You look clean." He looked about forty physical, with a high forehead, jet black eyebrows, a weak chin.

"Thanks a lot."

"You can approach. Message lasers only; no wideband transmission."

"Of course--"

"I'm a semisentient Virtual. There are copies of me all around your GUTship."

"I'm no trouble," she said tiredly.

"Make sure you aren't."

With Moro's pixel eyes on her, she brought the GUTship through a looping curve to the surface of the ice moon, and shut down its drive for the last time.

She stepped out onto the ancient surface of Chiron.

The ice was a rich crimson laced with organic purple. The suit's insulation was good, but enough heat leaked to send nitrogen clouds hissing around her footsteps, and

where she walked she burned craters in the ice. Gravity was only a few per cent of gee, and Gage, Mars-born, felt as if she might blow away.

Moro met her in person.

"You're taller than you look on TV," she said.

He raised a gun at her. He kept it there while her ship was checked over.

Then he lowered the gun and took her gloved hand. He smiled through his faceplate. "You're welcome here." He escorted her into the interior of Chiron.

Corridors had been dug hastily into the ice and pressurized; the wall surface -- Chiron ice sealed and insulated by a clear plastic -- was smooth and hard under her hand.

Moro cracked open his helmet and smiled at her again. "Find somewhere to sleep. Retrieve whatever you need from your ship. Tomorrow I'll find you a work unit; there's plenty to be done."

*Work unit?*

"I'm not a colonist," she growled. "You think we'll be here that long?"

Moro looked sad. "Don't you?"

She found a cabin, a crude cube dug into the ice. She moved her few personal belongings into the cabin -- Virtuals of her parents on Mars, book chips, a few clothes. Her things looked dowdy and old, out of place.

There were about a hundred people hiding in the worldlet. Fifty had come from a Mars-Saturn liner; the rest had followed in ones and twos aboard fugitive GUTship freighters, like Gage herself. There were no children. Except for the liner passengers -- mostly business types and tourists -- the colonists of Chiron were remarkably similar. They were wiry-looking, AntiSenescence-preserved, wearing patched in-ship uniforms, and they bore expressions -- uneasy, hunted -- that Gage recognized.

These were pilots. They feared, not discovery or death, but *grounding*.

The drives of some of the ships were dismantled and fixed to the surface, to provide power. The colonists improvised plants for air processing and circulation, for heating and for AS treatments. Crude distilleries were set up, with tubing and vessels cannibalized from GUTdrive motors.

Gage dug tunnels, tended vegetables, lugged equipment from GUTships of a dozen incompatible designs into the ice.

It was hard work, but surprisingly satisfying. The ache in her muscles enabled her to forget the worlds beyond Chiron, places she was coming to suspect she would never see again.

This was her home now, her Universe.

Two years limped by. The Chiron colony remained undiscovered. The grip of the Squeem occupation showed no sign of relaxing.

A mile below the surface the colonists dug out a large, oval chamber. The light, from huge strips buried in the translucent walls, was mixed to feel like sunlight, and soon there was a smell of greenery, of oxygen. People established gardens in synthesized soil plastered around the walls, and built homes from the ancient ice. The homes were boxes fixed to the ends of ice pillars; homes sprouted from the walls like flower-stalks.

Each dawn arrived with a brief flicker, a buzz as the strip-lights warmed up, then a flood of illumination. Gage would emerge from her cabin, nude; she could look down the length of her home-pillar at a field of cabbages, growing in ice as old as the Solar System.

It was like being inside a huge, gleaming egg. She missed Mars, the warm confines of her pilot cocoon.

The colonists monitored the news from the occupied worlds. There seemed to be no organized resistance; the Squeem's action had been too unexpected, too sudden and complete. As far as the colonists knew they were the only free humans, anywhere.

But they couldn't stay here forever.

They held a meeting, in an amphitheater gouged out of the ice. The amphitheater was a saucer-shaped depression with tiered seats; straps were provided to hold the occupants in place. As she sat there Gage felt a little of the cold of the worldlet, of two hundred miles of ice, seep through the insulation into the flesh of her legs.

Some proposed that the colony should become the base for a resistance movement. But if the massed weaponry of the inner planets hadn't been able to put up more than a token fight against the Squeem, what could one ad-hoc colony achieve? Others advocated doing nothing -- staying here, and waiting until the Squeem occupation collapsed of its own accord.

If it ever did, Gage thought morosely.

A woman called Maris Mackenzie released her belt and drifted up to the amphitheater's focal point. She was another pilot, Gage saw; her uniform was faded but still recognizable. Mackenzie had a different idea.

"Let's get out of this System and go to the stars," she said.

There was a ripple of laughter.

"How?"

"One day Saturn or Uranus is going to throw this ice dwarf out of the System anyway," Maris Mackenzie said. "Let's help it along its way. We use the GUTdrive modules to nudge it into a close encounter with one of the giants and slingshot out of the System. Then -- when we already have escape velocity -- we open up a bank of GUTdrives and push up to a quarter gee. We can use water-ice as reaction mass. In three years we'll be close to lightspeed--"

"Yes, but where would we go?"

Mackenzie was tall, thin, bony; her scalp was bald, her skull large and delicate: quite beautiful, like an eggshell, Gage thought. "That's easy," Mackenzie said. "Tau Ceti. We know there are iron-core planets there, but -- according to the Squeem data -- no advanced societies."

"But we don't know if the planets are habitable."

Mackenzie spread her thin arms theatrically wide. "We have more water, here in the bulk of Chiron, than in the Atlantic Ocean. We can *make* a world habitable."

"The Squeem will detect us when we open up the drives. They can outrun us with hyperdrive."

"Yes," said Mackenzie patiently, "but they won't spot us until after the slingshot. By then we'll already have escape velocity. To board us, the Squeem would have to match our velocity in normal space. We've no evidence they've anything more powerful than our GUTdrives, for normal spaceflight. So they couldn't outrun us; even if they bothered to pursue us they could never catch us."

"How far is Tau Ceti? It will take years, despite time dilation--"

"We *have* years," Mackenzie said softly.

A bank of cannibalized GUTdrive engines nudged Chiron out of orbit. It took three years for the ice dwarf to crawl to its encounter with Saturn.

The time went quickly for Gage. There was plenty of work to do. Sensors were ripped from the GUTships and erected in huge, irregular arrays over the ice-ship's surface, so they could watch for pursuit. Inside the ice cave, the colonists had to take apart their fancy zero-gee homes on stalks. One side of the chamber was designated the floor, and was flattened out; squat igloos were erected across the newly leveled surface. The vegetable farms were reestablished on the floor and on the lower slopes of the walls of the ice cave.

The colonists gathered on the surface to watch the Saturn flyby.

Gage primed her helmet nipple with whisky from one of the better stills. She found a place away from the rest, dug a shallow trench in the ice, and lay in it comfortably; vapor hissed softly around her, evoked by her leaked body heat.

Huge storms raged in the flat-infinite cloudscape of Saturn. The feathery surfaces of the clouds looked close enough to touch. Rings arched over Chiron like gaudy artifacts, unreasonably sharp, cutting perceptibly across the sky as Gage watched. It was like a slow ballet, beautiful, peaceful.

Saturn's gravitational field grabbed at Chiron, held it, then hurled it on.

Chiron's path was deflected towards the Cetus constellation, out of the plane of the Solar System and roughly in the direction of the Andromeda Galaxy. The slingshot accelerated the worldlet to Solar escape velocity. The encounter left the vast, brooding bulk of Saturn sailing a little more slowly around the remote Sun.

A week past the flyby the bank of GUTdrive engines was opened up.

Under a quarter gee, Gage sank to the new floor of the ice cave. She looked up at the domed ceiling and sighed; it was going to be a lot of years before she felt the exhilarating freedom of freefall again.

A week after that, riding a matchspark of GUTdrive light, the Squeem missile came flaring out of the plane of the System. It was riding a full gee.

The countdown was gentle, in a reassuring woman's voice. Gage lay with Moro in the darkness of her igloo. She cradled him in the crook of her shoulder; his head felt light, delicate in the quarter-strength gravity.

"So we got two weeks' head start," she said.

"Well, we'd hoped for longer--"

"A lot longer."

" -- but they were bound to detect the GUTdrive," Moro said. "It could have been worse. The Squeem must have cannibalized a human ship, to launch so quickly. So the missile's drive has to be human-rated, limited to a one-gee thrust."

The Squeem had evidently been forced to concur with Mackenzie's argument, that pursuit with a hyperdrive ship was impossible; only another GUTdrive ship could chase Chiron, crawling after the rogue dwarf through normal space.

The woman's voice issued its final warnings, and the countdown reached zero.

The ice world shuddered. Gage felt as if a huge hand were pressing down on her chest and legs; suddenly Moro's head was heavy, his hair prickly, and the ice floor was hard and lumpy under her bare back. The crown of her igloo groaned, and for a moment she wondered if it would collapse in on them.

The bank of GUTdrive pods had opened up, raising Chiron's acceleration to a full gee, to match the missile.

If Mackenzie's analysis was correct, Chiron couldn't outrun the missile, and the missile couldn't overtake Chiron. It was a stalemate.

Gage stroked the muscles of Moro's chest. "It's actually a neat solution by the Squeem," she murmured. "The pursuit will take years to play out, but the missile must catch us in the end."

Moro pushed himself away from her, rolled onto his front, and cupped her chin in his hands. "You're too pessimistic. We're going to the stars."

"No. Just realistic. What happens when we get to Tau Ceti? We won't be able to decelerate, or the missile will catch us. Although we may survive for years, the Squeem have destroyed us."



Moro wriggled on the floor, rubbing elbows which already looked sore from supporting his weight in the new thrust regime. He pulled at his lip, troubled.

Gage let herself get pregnant by Moro. The zygote was frozen, placed with a small store of others.

It was only after the storage of her zygote that Gage questioned her own motives in conceiving. How long was she expecting to be here? What kind of future did she think any of them could hope for?

Six months later the missile increased its acceleration to two gee.

The Squeem had been smart, Gage decided; they'd given the missile the ability to redesign itself in flight.

The colonists held another meeting to decide what to do. This time they sat around on the bare floor of their darkened ice cave; their elegant zero-gee amphitheater was suspended, uselessly, high on one wall of the cave.

Some wanted to stand and fight. But they had nothing to fight with. And Chiron, with its cargo of humanity, must be much more fragile than the hardened missile.

A few wanted to give up. They were still only fifty light days from the Sun. Maybe they could surrender, and return to the occupied worlds.

But most couldn't stand the idea; it would be better to die. Anyway, a semisentient Squeem missile was unlikely to take prisoners.

They voted to run, at two gee.

They had to rebuild their colony again. Drone robots crawled over the battered surface of the ice world, hauling water-ice to the GUTdrive engines. Shields billowed wings of electromagnetic flux around the ice dwarf; they would soon be running at close to light-speed, and the thin stuff between the stars would hit Chiron like a wall.

The beautiful ice cave was abandoned. It wouldn't be able to withstand the stress of two gravities. More tunnels were dug through the ice; new homes, made hemispherical for maximum strength, were hollowed out. The colonists strung lights everywhere, but even so Gage found their new warren-world gloomy, claustrophobic. She felt her spirits sinking.

The drives were ramped up to two gee in a day.

Only the strongest could walk unaided. The rest needed sticks, or wheelchairs. Broken bones, failing knees and ankles, were commonplace. Those like Gage who'd grown up on low-gravity worlds, or in freefall, suffered the most. The improvised AS units were forced to cope with a plague of failing hearts and sluggish circulations.

It was like growing old, in twenty-four hours.

Gage and Moro attempted sex, but it was impossible. Neither could support the weight of the other's body. Even lying side by side, facing each other, was unbearable after a few minutes. They touched each other tenderly, then lay on their backs in Moro's cavern, holding hands.

After three more months Maris Mackenzie came to see Gage. Mackenzie used a wheelchair; her large, fragile, beautiful bald head lolled against the back of the chair, as if the muscles in her neck had been cut.

"The missile is changing again," Mackenzie said. "It's still maintaining its two-gee profile, but its drive is flaring spasmodically. We think it's redesigning its drive; it's going to move soon to higher accelerations still. Much higher."

Gage lay on her pallet; she felt as if she could feel every wrinkle in the ice world under her aching back. "You can't be surprised. It was just a question of time."

"No." Mackenzie smiled weakly. "I guess I've screwed us up. We could have just stayed in our quiet orbit between Saturn and Uranus, not bothering anybody, flying around in that beautiful freefall ice cavern."

"The Squeem would have found us eventually."

"We're using up so much of our water. It breaks my heart. My beautiful ocean, thrown away into space, wasted. But we can go faster. We can still outrun the damn thing."

Gage knew that was true.

Once GUTenergy had fueled the expansion of the Universe itself. In the heart of each GUTdrive Chiron ice was compressed to conditions resembling the initial singularity -- the Big Bang. The fundamental forces governing the structure of matter merged into a single, Grand-Unified-Theory superforce. When the matter was allowed to expand again, the phase energy of the decomposing superforce, released like heat from condensing steam, was used to expel Chiron matter in a rocket action.

But none of that made a difference.

Gage sighed. "We've already abandoned half our tunnels because of tiny gradients we didn't even notice under one gee. We're slowly dying, under two gee, despite the AS units. We can't take anymore. I guess this latest maneuver of the missile will be the end for us."

"Not necessarily," Mackenzie said. "I have another idea." Gage turned her head slowly; she had to treat her skull as delicately as a china vase. "Your last one was a doozie. What now?"

"Downloading."

It wasn't a universally popular option. On the other hand, the alternative was death.

Eighty chose to survive, as best they could.

When her turn came Gage made her way, alone, to the modified AS machine at the heart of their warren of tunnels. The robot surgeon delicately implanted a sensor pad into her corpus callosum, the bridge of nervous tissue between the two hemispheres of her brain. It also, discreetly, pressed injection-pads against her upper arms.

All around her, in the improvised infirmary, people were dying, by choice.

So was Gage, if truth be told. All that would survive of her would be a copy, distinct from *her*.

The callosum sensor would download a copy of her consciousness in about eight hours. Gage returned to her cavern, lay on her back with a sigh, and fell asleep.

She opened her eyes.

She wasn't hurting anymore. She was in zero gee. It felt delicious, like swimming in candy floss. She was in the ice cave -- no, a Virtual reconstruction of the cave; the walls and house-stalks were just a little too smooth and regular. No doubt the realism of detail would return as their minds worked at this shared world.

Moro approached her; he'd resumed the crude disembodied-head Virtual form Gage had first encountered. "Hi." He grinned.

"I just died."

Moro shrugged. "Tell me about it. We're all stored inside the shelter now." This was a hardened radiation shelter they'd built hurriedly into the heart of the ice world; it contained a solid-state datastore to support their new Virtual existence, what was left of their vegetation, their precious clutch of human zygotes embedded in ice. "Our bodies have been pulped, the raw material stored in a tank inside the shelter."

"You've a way with words."

"...We're up to a thousand gee," Moro said.

Gage's Virtual reflexes hadn't quite cut in, so she made her mouth drop open. "*A thousand?*"

"That's what the missile is demanding of us. All our tunnels have collapsed."

"I never liked them anyway."

"And the drones are having to strengthen the structure of Chiron itself; the thing wasn't built for this, and could

collapse under the stress."

At a thousand gee, the time-dilation factor they would pile up would be monstrous. Gage found herself contemplating that, her growing isolation from home in space and time, with no more than a mild detachment.

Gage rubbed Virtual hands over her arms. Her flesh felt rubbery, indistinct; it was like being mildly anesthetized. Perhaps she was, in some Virtual way.

"Come on," she said. "Let's see what the food is like here."

The chase settled down to stalemate again.

Gage sat under (a Virtual image of) the sky, watching starlight bend itself into a bow around the ship. It was a beautiful sight; it reminded her of Saturn's rings.

Their speed was already so close to that of light that time was passing a thousand times as quickly inside Chiron as beyond it. Everyone Gage knew in the Solar System must be long dead, despite AS treatment.

She wondered if the Squeem occupation still endured. Maybe not. Maybe humans had hyperdrive ships of their own by now.

This solitary drama might be the last, meaningless act of a historical tragedy, yet to play to its conclusion.

Most of the eighty had retreated to Virtual playgrounds, sinking into their own oceanic memories, oblivious of the Universe outside, isolated even from each other.

But Gage was still out here.

New problems were looming, she thought.

She sought out Maris Mackenzie.

"We're going bloody fast," she said.

"I know." Maris Mackenzie looked lively, interested. "This is the way to travel between the stars, isn't it? Carrying live, fragile humans through normal space across interstellar distances was always a pipedream. Humans are bags of water, unreasonably fragile. A starship is nothing

but plumbing. Humans crap inordinate amounts, endless mountains of--"

"Yes," said Gage patiently, "but we still can't stop. Where are we going? Tau Ceti is long behind us. And we're heading out of the plane of the ecliptic, remember; we're soon going to pass out of the Galaxy altogether."

"Um." Mackenzie looked thoughtful. "What do you suggest?"

Gage set up a simulation of her old freighter's pilot cocoon; for subjective days she reveled in the Virtual chamber, home again.

But she got impatient. Her control and speed of reaction were limited.

She dismissed the cocoon and found ways to interface directly with the sensors of Chiron, internal and external.

The GUTdrive felt like a fire in her belly; the sensor banks, fore and aft, were her eyes.

It was odd and at first she ached, over all her imaginary body; but gradually she grew accustomed to her new form. Sometimes it felt strange to return to a standard-human configuration. She found herself staring at Moro or Mackenzie, still seeing arrays of stars, the single, implacable spark of pursuing GUTlight superimposed on their faces.

Gage had been a good pilot. She was prepared to bet she was a better pilot than the Squeem missile. If she learned to pilot Chiron, maybe she could find a way to shake off the missile.

She searched ahead, through the thinning star-fields at the edge of the Galaxy. She had to find something, some opportunity to trick the Squeem missile, before they left the main disc.

The black hole and its companion star lay almost directly in the path of Chiron.

The hole was four miles across, with about the mass of the Sun. Its companion was a red giant, vast and cool, its outer layers so rarefied Gage could see stars beyond its bulk.

Gage had found her opportunity.

She summoned Maris Mackenzie. A pale Virtual of Mackenzie's disembodied head floated over an image of the hole and its companion.

The hole raised tides of light in the giant. Material snaked out of the giant in a huge, unlikely vortex which marched around the giant's equator. The vortex fueled an accretion disc around the hole, a glowing plane of rubble that spanned more than Earth's orbit around its Sun.

Some of the giant's matter fell directly into the hole. The infall was providing the hole with angular momentum -- making it spin faster. Because of the infall the hole was rotating unusually fast, thirty times a second.

"Hear me out," Gage said.

"Go on," said Maris Mackenzie.

"If a black hole isn't spinning -- and it's uncharged -- then it has a spherical event horizon."

"Right. That's the Schwarzschild solution to Einstein's equations. Spherically symmetric--"

"But if you spin the hole, things get more complicated." It was called the Kerr-Newman solution. "The event horizon retreats in, a little way. And outside the event horizon there is another region, called the *ergosphere*."

The ergosphere cloaked the event horizon. It touched the spherical horizon at its poles, but bulged out at the equator, forming a flattened spheroid.

"The greater the spin, the wider the ergosphere," Gage said. "The hole ahead is four miles across. It's spinning so fast that the depth of the ergosphere at the equator is a hundred and forty yards."

Mackenzie looked thoughtful. "So?"

"We can't enter the event horizon. But we could enter the ergosphere, or clip it, and get away safely."

"Um. Inside the ergosphere we would be constrained to rotate with the hole."

"That's the plan. I want to flyby, clipping the ergosphere, and slingshot off the black hole."

Mackenzie whistled. Pixels fluttered across her face, as she devoted processing power to checking out Gage's proposal. "It could be done," she said eventually. "But we would have a margin of error measured in yards. It would require damn fine piloting."

"I'm a damn fine pilot. And we can take a lot of stress, remember." *It's not as if we have to protect anyone living.*

"Why do you want to do this?"

"Because," Gage said, "the missile will follow me through the ergosphere. But after we've passed through, the hole will have been changed. The missile won't be able to work out how..."

"We'll have to get consent to this from the others. The eighty--"

"Come on," Gage said. "Most of them have retreated into their own Virtual heads. There's hardly anybody out here, still thinking, save you and me."

Slowly, Mackenzie smiled.

For Gage's scheme to work, the speed of Chiron would have to be raised much higher. When Chiron flew by the hole it would need an angular momentum comparable to that of the hole itself. So the drones ravaged Mackenzie's frozen ocean, hurling the stuff of Chiron into the GUTdrives.

Chiron approached the lightspeed limit asymptotically.

By the time the hole approached, Chiron's effective mass had reached about a tenth of the Sun's. For every second passing in its interior, a hundred years wore away outside.



Ahead of her, the radiation from the black hole's accretion disc was Doppler-shifted to a lethal sleet. Massive particles tore through the neural nets which comprised her awareness. She felt the nets reconfigure, healing themselves; it was painful and complex, like bone knitting.

Behind her the redshifted emptiness was broken only by the patient, glowering spark of the Squeem missile.

The black hole was only seconds away. She could make those seconds last a Virtual thousand years, if she wished.

In these last moments, she was assailed by doubt. Nobody had tried this maneuver before. Had she destroyed them all?

Gage let her enhanced awareness pan through the bulk of Chiron. Years of reaction-mass plundering had reduced the ice dwarf to a splinter, but it would survive to reach the lip of the black hole -- and so would its precious cargo, the awareness of eighty downloaded humans, the canister containing their clutch of frozen zygotes. That canister felt like a child, inside her womb of ice.

*Enough.*

She reduced her clock-speed to human perception. The black hole flew at her face--

The misty giant companion star ballooned over Gage's head, its thin gases battering at her face.

Chiron's lower belly dipped fifty yards into the ergosphere. The gravitational pull of the hole gripped her. It felt like pliers in her gut. She was hurled around; she was a helpless child in the grip of some too-strong adult. The fabric of Chiron cracked; Solar System ice flaked into this black hole, here on the edge of the Galaxy, flaring X-radiation as it was crushed.

Then the gravity grip released. The hole system was behind her, receding. The pit dug in spacetime by the hole's mass felt like a distant, fading ache.

She watched the patient GUTspark of the Squeem missile as it approached the hole. It matched her path almost exactly, she saw with grudging admiration.

The missile grazed the lip of the hole. There was a flare of X-radiation.

The GUTspark was gone.

*It's worked. By Lethe, after all these years, it's worked.*

Suddenly Gage felt utterly human. She wanted to cry, to sleep, to be held.

Cydonia, her home arcology, was an angular pyramid, huge before her, silhouetted against the light of the shrunken Sun. The ambient Martian light was like a late sunset, with the arcology drenched in a weak, deep pink color; against its surface its windows were rectangles of fluorescent light glowing a harsh pearl gray, startlingly alien.

Her boots had left crisp marks in the duricrust.

Gage wasn't nostalgic, usually, but since the hole flyby she had felt the need to retreat into the scenes and motifs of her childhood.

Moro and Mackenzie met her on this simulated Martian surface.

"It was simple," she said.

Mackenzie smiled.

Moro growled. "You've told us."

"We took so much spin from the black hole that we almost stopped it rotating altogether. It became a Schwarzschild hole. Without spin, its event horizon expanded, filling up the equatorial belt where the ergosphere had been."

Chiron had clipped the ergosphere safely. The missile, following Chiron's trajectory exactly, had fallen straight into the expanded event horizon.

The long chase was over.

"I guess the missile wasn't an expert on relativistic dynamics after all," Mackenzie said.

"But we're not so smart either," Moro said sourly. "After all we're still falling out of the Galaxy -- even faster than before the hole encounter, in fact. A million years pass for every month we spend in here; we might be the only humans left alive, anywhere." He looked down at his arms, made the pixels swell absurdly. "If you can call this life. *And* we don't have enough reaction mass left to slow down. Well, space pilot Gage, where are we heading now?"

Gage thought about it. They could probably never return to their home Galaxy. But there were places beyond the Galaxy, massive stars and black holes that a pilot could use to decelerate, if she was smart enough.

And if they could find a place to stop, they could rest. Maybe Gage's awareness could be loaded back into some flesh-and-blood simulacrum of a human form. Or maybe not; maybe the role of Gage and the rest would simply be to oversee the construction of a new world fit for her child, and the other frozen zygotes.

She smiled. "At this speed, we'll be there in a couple of subjective months."

"Where?"

"Andromeda..."

*Even under the oppressive Squeem occupation, humans learned much.*

*They learned, for example, that much of the Squeem's high technology -- their hyperdrive, for instance -- was not indigenous. It was copied, sometimes at second or third hand, based on the designs of an older, more powerful species...*

*"It was the first time," Eve said, "that the name 'Xeelee' entered human discourse."*

*I shuddered.*

# The Xeelee Flower

**A.D. 4922**

I still get tourists out here, you know. Even though it's been so long since I was a hero. But then, I'm told, these days the reopened Poole wormholes will get you from Earth to Miranda in hours.

Hours. What a miracle. Not that these tourist types appreciate it. Don't get me wrong, I don't mind the company. It just bugs me that every last one, after he's finished looking over my villa built into the five-mile cliffs of Miranda, turns his face up to the ghostly blue depths of Uranus, and asks the same dumb question:

"Say, buddy, how come you use a fish tank for a toilet?"

But I'm a good host, and I merely smile and snap my fingers. After a while, my battered old buttlebot limps in with a bottle of valley bottom wine, and I settle back and begin:

"Well, my friend, I use the fish tank for a toilet for the same reason you would. Because my boss used to live in it."

And that's how I got where I am today.

By working for a bunch of fish, I mean, not pissing in the tank. Although I don't know what stopped me from doing just that by the time we reached Goober's Star eight months out from Earth.

"The resolution, Jones, the resolution!" The shoal of Squeem darted anxiously around their tank, griping at me from the translator box taped to one glass wall.

I put down the spare tank I'd been busy scraping out, and blinked across the cluttered little cabin. The buttlebot - - yes, the same one, squeaky-clean in those days -- scuttled

past, humming happily in its chores. I picked my way to the control panel. I got out my adjustable spanner and gingerly tweaked the fiddly little enhancement vernier. Like most Xeelee-based technology it was too fine for human fingers. The secretive Xeelee evidently have great brains but tiny hands. Then again, some people haven't managed to evolve hands at all, I reflected, as the Squeem flipped around in their greenish murk.

"Ah," enthused the Squeem as the monitors sharpened up. "Our timing is perfect."

I gloomily considered a myriad beautiful images of two things I didn't want much to be close to: Goober's Star -- about G-type, about two Earth orbits away, and about to nova; and a planet full of nervous Xeelee.

And the most remarkable feature of the whole situation was that we weren't running for our lives. In fact, we were going to get closer -- a lot closer -- drawn mothlike by the greed of the Squeem for stolen Xeelee treasure.

The buttlebot squeezed past my leg, extended a few pseudopodia, and began pushing buttons with depressing enthusiasm. I sighed and turned back to my fish tank. At least I had one up on the 'bot, I reflected; at least I was getting paid. Although, like most of the rest of humanity at that time, I hadn't exactly had a free choice in the nature of my employment--

The Squeem's rasp broke into my thoughts. "Jones, our planet-fall is imminent. Please prepare the flitter for your descent."

Your descent. Had they said "your" descent? I nearly dropped the fish tank.

Carefully, I got up from my knees. "Into Lethe's waters with that." I defiantly straightened my rubber gloves. "No way. The Xeelee wouldn't let me past the orbit of the moons--"

"The Xeelee will be fully occupied with their flight from the imminent nova. And your descent will be timed to

minimize your risk."

"That's a lot of 'you' and 'your,' " I observed witheringly. "Show me where my contract says I've got to do this."

Can fish be said to be dry? The Squeem said drily, "That will be difficult as you haven't got a contract at all."

They had a point. I reluctantly took off my pinafore and began to tug at the fingers of my rubber gloves. The buttlebot smugly opened up the suit locker. "You ought to send that little tin cretin," I said; and the Squeem replied, "We are."

I swear to this day that buttlebot jumped.

And so the buttlebot and I found ourselves drifting through a low orbit over the spectacular Xeelee landscape. We watched morosely as the main ship pulled away from the tiny, human-design flitter, and wafted our employer off to the comparative safety of the far-side of one of the planet's two moons.

My work for the Squeem, roughly speaking, was to do any fiddly, dirty, dangerous jobs the buttlebot wasn't equipped for, such as to clean out fish tanks and land on hostile alien planets. And me, a college graduate. Of course, the role of humanity at that time was roughly equivalent.

It isn't that the Squeem -- or any of the other races out there -- were any brighter than we were or better or even much older. But they had something we didn't, and had -- then -- no way of getting our hands on.

And that was stolen Xeelee technology. For instance the hyperdrive, scavenged by the Squeem from a derelict Xeelee ship centuries earlier, had been making that fishy race's fortune ever since. Tools and gadgets of all kinds, on which a Galactic civilization had been based. And all pilfered, over millions of years, from the Xeelee.

I use the word civilization loosely, of course. Can it be used to describe what exists out there -- a ramshackle

construct based on avarice, theft and the subjugation of junior races like ourselves?

We began our descent. The dark side of the Xeelee world grew into a diamond-studded carpet: fantastic cities glittered on the horizon. *The Xeelee* -- so far ahead, they make the rest of us look like tree-dwellers. Secretive, xenophobic. Not truly hostile to the rest of us; merely indifferent. Get in their way and you would be rubbed aside like a mote in the eye of a god.

And I was as close to them as any sentient being had ever got, probably. Nice thought.

Yes, like gods. But very occasionally careless. And that was the basis of the Squeem's plan that day.

We dropped slowly. The conversation left a lot to be desired. And the surface of the planet blew off.

I recoiled from the sudden light at the port, and the buttlebot jerked us down through the incredible traffic. It looked as if whole cities had detached from the ground and were fleeing upwards, light as bubbles. The flitter was swept with shifting color; we were in the down elevator from Heaven.

Abruptly as it had risen, the Xeelee fleet was past. Immense, night-dark wings spread over the doomed planet for a moment, as if in farewell; and then the fleet squirted without fuss into infinity. Evidently, we hadn't been noticed.

The flitter moved in looser arcs now towards the surface. I took over from the buttlebot and began to seek out a likely landing place. We skimmed over a scoured landscape.

From behind the darkened planet's twin moons, the valiant Squeem poked their collective nose. "The nova is imminent; please make haste with your planetfall."

"Thanks. Now get back in your tin and let me concentrate." I wrestled with the flitter's awkward controls;

we lurched towards the ground. I cursed the Xeelee under my breath; I thought of fish pie; I didn't even much like the buttlebot. The last thing I needed at a time like that was a reminder that what I was doing was about as clever as looting a house on fire. Get in after the owners have fled; get out before the roof caves in. The schedule was kind of tight.

Finally, we thumped down. Reproachfully, the buttlebot uncoiled its pseudopodia from around a chair leg, let down the hatch and scuttled out. Already suited up, I grabbed a data desk and flashlight laser, and staggered after it. That descent hadn't done me a lot of good either, but in the circumstances I preferred not to hang around.

I emerged into a bonelike landscape. The noise of my breath jarred in the complete absence of life. I imagined the planet trembling as its bloated sun prepared to burst. It wasn't a happy place to be.

I'd put us down in the middle of a village-sized clump of buildings, evidently too small or remote to lift with the rest of the cities. In a place like this we had our best chance of coming across something overlooked by the Xeelee in their haste, some toy that could revolutionize the economies of a dozen worlds.

Listen, I'm serious. It had happened before. Although any piece of junk that would satisfy the Squeem and let me get out of there would do for me.

The low buildings gaped in the double shadows of the moonlight. The buttlebot scurried into dark places. I ran my hand over the edge of a doorway, and came away with a fine groove in a glove finger. The famous Xeelee construction material: a proton's width thick, about as dense as glass wool, and as strong as Life itself. And no one had a clue how to make or cut it. Nothing new; a familiar miracle.

The buttlebot buzzed past excitedly, empty-handed. The vacant place was soulless; there was nothing to evoke the



people who had so recently lived here. The thorough Xeelee had even evacuated their ghosts.

"Squeem, this is a waste of time."

"I estimate some minutes before you should ascend. Please proceed; I am monitoring the star."

"I feel so secure knowing that." I tried a few more doorways. The flashlight laser probed emptiness. -- Until, in the fourth or fifth building, I found something.

The artifact, dropped in a corner, was a little like a flower. Six angular petals, which looked as if they were made of Xeelee sheeting, were fixed to a small cylindrical base; the whole thing was about the size of my open hand. An ornament? The readings from my data desk -- physical dimensions, internal structure -- didn't change as I played with the toy in the light of the flashlight laser. Half the base clicked off in my hand. Nothing exciting happened. Well, whatever it was, maybe it would make the Squeem happy and I could get out.

I took it out into the moonlight. "Squeem, are you copying?" I held it in the laser beam, and twisted the base on or off.

The Squeem jabbered excitedly. "Jones! Please repeat the actions performed by your opposable thumb, and observe the data desk. This may be significant."

"Really." I clicked the base on and off, and inspected the exposed underside in the laser light. No features. But a readout trembled on the data desk; the mass was changing.

I experimented. I took away the torch: the change in mass, a slow rise, stopped. Shine the torch, and the mass crept up. And when I replaced the base, no change with or without the torch. "Hey, Squeem," I said slowly, "are you thinking what I'm thinking?"

"Jones, this may be a major find."

I watched the mass of the little flower creep up in the light of the torch. It wasn't much -- about an ounce per second, to be exact -- but it was there. "Energy to mass,

right? Direct conversion of the radiant energy of the beam." And the damn thing wasn't even warm in my hand.

I clicked the base back into place; the flower's growth stopped. Evidently, the base was a key; remove it to make the flower work. The Squeem didn't remark on this; for some reason, I didn't point it out. Well, I wasn't asked.

"Jones, return to the flitter at once. Take no further risks in the return of the artifact."

That was what I wanted to hear. I ran through the skull-like town, clutching the flower. The buttlebot scurried ahead. I gasped out, "Hey, this must be what they use to manufacture their construction material. Just stick it out in the sunlight, and let it grow." Presumably the petals, as well as being the end product, were the main receptors of the radiant energy. In which case, the area growth would be exponential. The more area you grow, the more energy you receive; and the more energy you receive, the more area you grow, and...

I thought of experiments to check this out. Listen, I had in my hand a genuine piece of Xeelee magic; it caught my imagination. Of course, the Squeem would be taking the profits. I considered ways to steal the flower...

My feet itched; they were too close to a nova. I had other priorities at that point. I stopped thinking and ran.

We bundled into the flitter; I let the buttlebot lift us off, and stored the Xeelee flower carefully in a locker.

The lift was bumpy: high winds in the stratosphere. A spectacular aurora shivered over us. "Squeem, are you sure you've done your sums right?"

"There is an inherent uncertainty in the behavior of novae," the Squeem replied reassuringly. We reached orbit; the main ship swam towards us. "After all," the Squeem lectured on, "a nova is by definition an instability. However I am confident we have at least five minutes before--"

At once, three events.

The moons blazed with light.

The Squeem shut up.

The main ship turned from a nearby cylinder into an arrow of light, pointing at the safety of the stars.

"Five minutes? You dumb fish."

The buttlebot worked the controls frantically, unable to comprehend the abrupt departure of the Squeem. The nova had come ahead of schedule; the twin moons reflected its sick glory. We were still over the dark side of the planet, over which screamed a wind that came straight from the furnaces of a medieval hell. On the day side, half the atmosphere must already have been blasted away.

The flitter was a flimsy toy. I estimated we had about ten minutes to sunrise.

My recollection of the first five of those minutes is not clear. I do not pretend to be a strong man. I remember an image of the walls of the flitter peeling back like burnt flesh, the soft interior scoured out...

Leaving one object, one remnant, spinning in a cloud of metal droplets.

I realized I had an idea.

I grabbed the Xeelee flower from its locker, and wasted a few more seconds staring at it. The only substance within a million miles capable -- maybe -- of resisting the nova, and it was the size of my palm. I had to grow it, and fast. But how?

My brain chugged on. Right. One way. But would there be time? The flower's activating base came off, and went into a suit pocket.

The buttlebot was still at the controls, trying to complete its rendezvous with a vanished ship. If there'd been time, I might have found this touching; as things were, I knocked it aside and began entering an emergency sequence. My thinking was fuzzy, my gloved fingers clumsy, and it took three tries to get it right. You can imagine the effect on my composure.

Now I had about a minute to get to the back of the vessel. I snapped closed my visor and de-cycled the airlock. I failed to observe the mandatory safety routines, thus voiding the manufacturer's guarantees. The buttlebot clucked nervously about the cabin.

Clutching the Xeelee flower, I pulled into space and set off one-handed.

I couldn't help looking down at the stricken planet. Around the curve of the world, the air rushing from the day side was gathering into a cyclone to end all cyclones; clouds swarmed like maggots, fleeing the boiling oceans. A vicious light spread over the horizon.

Followed by the confused buttlebot, I made it to the reactor dump hatch. In about thirty seconds, the safety procedure I had set up should funnel all the flitter's residual fusion energy out through the hatch into space, in one mighty squirt. Except, the energy pulse wasn't going to reach free space; it would all hit the Xeelee flower, which I was going to fix into place over the hatch.

Right. Fix it. With what? I fumbled in my suit pockets for tape. A piece of string. Chewing gum. My mind emptied. The buttlebot scuttled past, intent on some vital task.

I grabbed it, and wrapped the flower in one of its pseudopodia. "Listen," I screamed at it, "stay right here. Got it? Hold it for five seconds, please, that's all I ask."

No more time. I scrambled to the far side of the flitter.

Five seconds isn't long. But that five seconds was long enough for me to notice the brightening of the encroaching horizon. Long enough to note that I was gambling my life on a few more or less unfounded assumptions about the Xeelee flower.

It had to be a hundred percent efficient; if it couldn't absorb all that was about to be thrown at it, then it would evaporate like dew. It had to grow exponentially, with the rate of growth area increasing with the area grown already.

Otherwise it couldn't grow fast enough to save me as planned.

I also had plenty of time to wonder if the buttlebot had got bored--

There was a flash. I peered around the flitter's flank.

It had worked. The flower had blossomed in the fusion light into an umbrella-sized dish, maybe just big enough for the hard rain that was going to fall.

The flower tumbled slowly away from the now-derelict flitter, as did the buttlebot, sadly waving the melted stump of one pseudopod. I kicked it out of the way, and pushed into space. The heat at my back was knife-sharp.

I reached the flower and curled into a ball behind it. The light flooded closer, beading the edge of my improvised shield. I imagined the nova's lethal energy thudding into the material, condensing into harmless sheets of Xeelee construction material. My suit ought to protect me from the nasty heavy particles which would follow. It was well made, based on Xeelee material, naturally... I began to think I might live through this.

I waited for dawn. The buttlebot tumbled by, head over heels. It squirmed helplessly, highlights dazzling in the nova rise.

At the last moment I reached out and pulled it in with me. It was the stupidest thing I have ever done.

The nova blazed.

The flitter burst into a shower of metal rain. The skin of the planet below wrinkled, like a tomato in steam.

And that buttlebot and I rode our Xeelee flower, like surfers on a wave.

It took about twelve hours. At the end of that time, I found I could relax without dying.

I slept.

I woke briefly, dry-mouthed, muscles like wood. The buttlebot clung to my leg like a child to a doll.

We drifted through space. The flower rotated slowly, half-filling my field of view. Its petaled shadow swept over the wasted planet. It must already have been a mile across, and still growing.

What a spectacle. I slept some more.

The recycling system of my suit was designed for a couple of eight-hour EVA shifts. The Squeem did not return from their haven, light years distant, for four days.

I did a lot of thinking in that time. For instance, about the interesting bodily functions I could perform into the Squeem's tank. And also about the flower.

It grew almost visibly, drinking in the sunlight. Its growth was exponential; the more it grew, the more capacity it had for further growth -- I did some woolly arithmetic. How big could it grow?

Start with, say, a square mile of construction material. I made educated guesses about its surface density. Suppose it gets from the nova and surrounding stars about what the Earth receives from the Sun -- something over a thousand watts a square yard. Assume total efficiency of conversion: mass equals energy over cee squared.

That gave it a doubling time of fifteen years. I dreamed of numbers: one, two, four, eight, sixteen... It was already too big to handle. It would be the size of the Earth after a couple of centuries, the size of Sol a little later.

Give it a thousand years and you could wrap up the Galaxy like a birthday present. Doubling series grow fast. And no one knew how to cut Xeelee construction material.

The Universe waltzed around me; I stroked the placid buttlebot. My tongue was like leather; the failing recycling system of my suit left a taste I didn't want to think about.

I went over my figures. Of course, the growing flower's power supply would actually be patchy, and before long the

edge would be spreading at something close to the speed of light. But it would still reach an immense size. And the Xeelee hadn't shown much interest in natural laws in the past. We drifted into its already monstrous eclipse; the buttlebot snuggled closer.

This was the sort of reason the Xeelee didn't leave their toys lying around, I supposed. The flower would be a hazard to shipping, to say the least. The rest of the Galaxy weren't going to be too pleased with the Squeem...

These thoughts sifted to the bottom of my mind, and after a while began to coalesce.

The secret of the hyperdrive: yes, that would be a fitting ransom. I imagined presenting it to a grateful humanity. Things would be different for us from now on.

And a little something for myself, of course. Well, I'd be a hero. Perhaps a villa, overlooking the cliffs of Miranda. I'd always liked that bust-up little moon. I thought about the interior design.

It was a sweet taste, the heady flavor of power. The Squeem would have to find a way to turn off the Xeelee flower. But there was only one way. And that was in my suit pocket.

Oh, how they'd pay. I smiled through cracked lips.

Well, you know the rest. I even got to keep the buttlebot. We drifted through space, dreaming of Uranian vineyards, waiting for the Squeem to return.

*The images faded.*

*"I liked Jones," I said.*

*"Because he didn't give up. I know you, Jack."*

*"And he won, didn't he?"*

*"Yes. Jones's small victory would, indeed, prove to be the turning point in human oppression by the Squeem..."*

*The yoke of the Squeem was cast off. Humans were free again, able to exploit themselves and their own resources*

*as they saw fit. Not only that, the Squeem occupation had left humans with a legacy of high technology.*

*The lost human colonies on the nearby stars were contacted and revitalized, and a new, explosive wave of expansion began, powered by hyperdrive. Humans spread like an infection across the Galaxy, vigorous, optimistic once more.*

*And everywhere, they encountered the footprints of the Xeelee...*



## More Than Time or Distance

**A.D. 5024**

My one-woman flitter dropped into the luminous wreckage of an old supernova. I peered into the folded-out depths of the dead star, hoarding details like coins for Timothy.

The star remnant at the heart of the wreck was a shrunken miser; its solitary planet was a ball of slag pockmarked with shallow craters. Once this must have been the core of a mighty Jovian. I landed and stepped out. Feel how the surface crackles like glass, Tim... I imagined four-year-old eyes round with wonder. Except, of course, my memory of my son was five years and a thousand light years out of date. But I felt Tim's presence, somehow -- when you get close enough to someone you're never really alone again. And maybe if my prospector's luck changed here, it wouldn't be five years before I held him again.

Above me violet sails of gas drifted through a three-dimensional sky. Around me a thousand empty light years telescoped away. And ahead of me stood a building -- plain, cuboid, a bit like a large shoe box.

But a shoe box at the center of a nebula -- and made of Xeelee construction material.

I stood stock still, the hairs at the back of my neck prickling against the lining of my pressure suit. An original Xeelee relic, the dream of prospectors from a thousand races... and intact, too.

The exploded star washed blank walls with light like milk. I expected a giant to step through that low doorway... I thought of one of Timothy's jokes. What do you call a giant alien monster with a zap gun?

You know it. Sir.

I stepped through the doorway. The wall material was sword-thin.

The ceiling was translucent; supernova filaments filled the place with violet and green shadows. My eyes were drawn to a flicker of light, incongruously playful: about five yards from the doorway a small pillar supported a hoop of sky blue, which was maybe two feet wide. The hoop was polished and paper-thin, and a sequence of pink sparks raced around its circumference.

About thirty yards further down the long axis of the hall was a second pillar bearing an identical hoop. The two circles faced each other, chattering bits of light.

That was all. But it was enough to stop my heart. Because whatever this place was, it was still working -- and working for the Xeelee, lurking like watchful spiders in their Prime Radiant at the Galaxy's core -- only three days away in their magical ships.

I stepped forward with my portable data desk and began to mark and measure.

The sequence of sparks in the hoop nearest the door was random, as far as I could tell. So was the sequence in the other hoop -- but it was an exact copy of the first sequence, delayed by a nanosecond.

I worked out the implications of that, and then I leaned carefully against a low pillar and breathed deep enough to mist up my face plate.

Think about it. Ring A was talking to ring B, which got the message delayed by a nanosecond. Each ring was a light nanosecond across. And the rings were placed a hundred light nanoseconds apart.

So all the delay was in the structure of the rings -- and the communication between them was instantaneous.

My face plate fogged a bit more. Instantaneous communication: it was a technological prize second only in

value to the hyperdrive itself...

The secret had to be quantum inseparability. When a single object is split up, its components can still communicate instantaneously. That's high school stuff, Bell's theorem from the twentieth century. But, everyone had thought, you couldn't use the effect to send meaningful messages.

The Xeelee had really got their fingers into the guts of the Universe this time. It was almost blasphemous.

And very, very profitable.

My sense of awe evaporated. I found myself doing a sort of dance, still clinging to the pillar, booted heels clicking. Well, I had an excuse. It was the high point of my life.

And at just that moment, in walked a giant alien monster with a zap gun. Wouldn't you know it?

At least it wasn't a Xeelee. About all we know of them is that they're small, physically. My superstitious terror faded to disgust.

"You tailed me," I said into my suit radio. "You sneaked up on me, and now you're going to rob me and kill me. Right?" I looked at the zap gun and remembered the joke. "Right, sir?"

I don't suppose it got it. Silhouetted against a violet doorframe was a humanoid sketch in gun-metal gray. Its head was a cartoon; all the action was in a porthole in its stomach, through which I caught grotesque hints of faces. It was like an inside-out bathyscaphe with weird sea-bottom creatures peering out of darkness.

And it had the zap gun. The details of that don't really matter; it was essence of gun and it was pointing at me.

I labeled it the Statue.

The silence dragged on, maybe for dramatic effect, more likely because the Xeelee-derived translator box I saw strapped to one metal thigh was having trouble matching up our respective world pictures. Finally it spoke.

"Allow me to summarize the situation." The box's voice was a machine rasp; the stomach monster twitched. "I have discontinued your vessel. I estimate your personal environment will last no more than five human days. You have no weapons, or any means of communication with your fellows -- none of whom are in any event closer than a thousand light years."

I thought it over. "Okay," I said, "I'm prepared to discuss terms for your surrender."

"The logic of the situation is that you will die. You will therefore move outside this structure--"

Actually the logic was that I was dead already. I thought fast, looking for the edge. "Of course, you're right." I stepped forward--

-- and whirled like a leaf -- and snapped one sky blue hoop off its pillar -- and draped it around my neck.

It was over before either of us had a chance to think about it. The whirling pink sparks faded and died.

The Statue's limbs were motionless but its stomach thrashed. I felt breathless and foolish; the hoop around my neck was like a lavatory seat put there during a drunken teenage party. "Logic's not my strong point," I apologized.

You see, I had a plan. It wasn't a very good plan, and I was probably dead even if it came off. But it was all I had, and I noticed I was still breathing.

The Statue stared. "You have damaged the artifact."

"You see, there had to be a reason why you didn't shoot me in the back before I knew about it. And that reason's got to be your ignorance of humans. Right?" I snapped. "Despite the fact that you and your kind have been tailing me for months--"

"Actually years. We find humans are resourceful creatures, worthy of study."

"Years, then -- if you zapped me, maybe I'd explode, or melt, or in general make a horrible mess of the Xeelee

equipment. And you won't hurt me now for fear of doing even more damage." I clung to the frail hoop around my neck.

The Statue moved further into the building, the interesting end of the zap gun unwavering. We stood along the axis of the structure. The Statue said patiently, "But even with this awareness you are scarcely at an advantage."

I shrugged.

"You are still isolated and without resources." The Statue seemed confused. "All I have to do is wait five days, when you will die in undignified circumstances and I will retrieve the artifact."

"Ah," I said mysteriously. "A lot can happen in five days." In fact, maybe in three -- I kept that to myself.

The stomach monster thrashed.

I walked around the pillar and sat down, taking care not to squash my catheter. "So we wait." I settled the hoop more comfortably around my neck.

Giant wings of gas flapped slowly beyond the translucent ceiling, and the hours passed.

Time stretches like a lazy leopard when it wants to.

I spent a day staring out a statue and not thinking about my catheter -- or Tim.

I snapped out, "You've no idea what you're stealing from me here."

The Statue hesitated. "I believe I do. This is clearly a Xeelee monitoring station. Presumably one of a network spread through the Galaxy."

Instantly I wished I hadn't spoken. If it had thought through as far as that... to distract it, I said, "So you watched my experiments?"

"Yes. What we see must be a test rig for the instantaneous communication device."

"How do you suppose it works?" Stick to details; keep it off the Xeelee--

A longer pause. Through the ceiling skin I watched a cathedral of buttressed smoke. The Statue said, "I fear the translator box cannot provide the concepts... At one time these two hoops were part of a single object. And an elementary particle, an electron perhaps, would be able to move at random between any two points of that object, without a time lapse."

"Yeah. This is quantum physics. The electron we perceive is an 'average' of an underlying 'real' electron. The real electron jumps about over great distances within a quantum system, quite randomly and instantaneously. But the average has to follow the physical laws of our everyday experience, including the speed of light limit."

"The point," it said, "is that the real electron will travel at infinite speed between all parts of an object -- even when that object has been broken up and its parts separated by large distances, even light years."

"We call that quantum inseparability. But we thought you could use it only to send random data, no information-bearing messages."

"Evidently the Xeelee do not agree," the Statue said dryly. "It took many generations before my species could be persuaded that the elusive 'real' electron is a physical fact, and not a mathematical invention."

I smiled. "Mine, too. Maybe our species have got more in common than they realize."

"Yes."

Well, that was a touching thought which augured hope for the future of the Galaxy. But I noticed it didn't touch the zap gun.

The thing in the Statue's stomach started to feed on something; I turned away. The gloom deepened as the pale supernova remnant was eclipsed by the edge of the ceiling. I tried to sleep.

The first day was bad enough, but the second was the worst. Except for the third.

For me, anyway. The suit had water and food -- well, a syrup nipple -- but the recycling system wasn't designed for a long vacation. I didn't want to lose face by sluicing out my plumbing system all over the floor. And so, when I went for my regular walks around the bereft pillar, I sloshed.

By contrast, the Statue was unmoving, machinelike. Bizarre fish swam in its stomach, and the zap gun tracked me like the eye of a snake.

On the third day I stood by my pillar, swaying in unstable equilibrium. I didn't have to feign weakness. I sneaked glances at the futuristic sky. I had to time things just right--

At length, the Statue said, "You are weakening and will surely die. But this has always been inevitable. I do not understand your motivation."

I laughed groggily. "I'm waiting for the cavalry."

The stomach creature twitched uneasily. "What is this 'calvary'?"

Too uneasy. I shut myself up with the truth. "Maybe I just don't like being robbed. I'm a prospector for Xeelee gold, but it's not just for me. Can you understand that? It's for my son. My off-spring. That's what you're taking from me, and I don't even know what you are."

A flicker in the sky like the turn of a page.

It was time. I stumbled to my knees.

The Statue said, not unkindly, "You have been a worthy opponent. I will allow you to end your life according to the custom of your species."

"Thank you. I -- I guess it's over." I forced myself to my feet, took the hoop from my neck, and laid it reverently atop the little pillar. I began walking stiffly towards the door, feeling ashamed of my trickiness. Amazing, isn't it. "I'd like to die outside," I said solemnly.

The Statue glided away from the doorway, respectfully lowering its zap gun.

I got outside the building. Another shudder across the weird sky. I limped around the corner of the building--

-- and ran for my life. My legs were like string, shivering from under use. A bar of light swept behind the stars. There were tiny explosions in my peripheral vision; it was as if something was solidifying out of the layer of space that cloaked the planet.

The Xeelee didn't believe in a quiet entrance.

I tumbled face first into a shallow crater and stayed that way. It didn't feel deep enough; I imagined my backside waving like a flag to the marauding Xeelee.

A giant started stomping around me. I held onto my head and waited for the pounding to stop. I glimpsed wings, night-dark, hundreds of miles wide, beating over the planet, eclipsing the glowing gas.

The planet stopped shivering.

I tried to move. My muscles were like cardboard. Pieces crackled off the back of my suit, which was burnt to a crisp. I walked from the crater scattering scabs like an unearthly leper.

I reached the site of the Xeelee station. I was a fly at the edge of a saucer; the hole was a perfect hemisphere, a hundred yards wide. I skirted it carefully, heading for a sparkle of twisted metal beyond it.

The Statue lay like Kafka's cockroach, its sketch of a head battered into concavity, its limbs and torso crumpled. Fluid bubbled through a crack in the porthole, and something inside looked out at me listlessly.

The translator box was hesitant and scratchy, but intelligible. "I... wish to know."

I knelt beside it. "Know what?"

"How you knew when... they would come."



"Neat timing, huh?" I shrugged. "Well, the clues were there for both of us."

"Quantum inseparability?"

"Signals will pass instantaneously between a communicator's two halves. But those halves must once have been in physical contact. Once joined, they can never be truly parted. Like people," I mused. "It takes more than time or distance--"

"I begin to... understand."

"The components of this station, and all its clones throughout the Galaxy, must have been carried here from a central exchange. That's where the repairmen we've just, ah, encountered, must have come from. And the exchange has to be at the Xeelee home base, at the Galaxy core. Three days' travel for the Xeelee."

"So they had to come. But the Xeelee Prime Radiant is a matter of speculation. You did not know--"

I grinned ruefully. "Well, I knew for sure I'd had it unless I took a long shot. Your precious logic demonstrated that."

More bubbles from the stomach, and the voice grew weaker. "But your... ship is destroyed. Your victory does not bring success."

"Yeah." I sat in crunchy dirt beside the dying Statue. "I guess I didn't like to think this far ahead." The depth of focus seemed to shift; light years expanded around me.

Even the Statue was company. "You have been a worthy... opponent."

"You're repeating yourself," I said rudely.

"My ship is at... the planet's nearer pole, one day's journey from here. You may be able to adapt its life system to your purposes."

"Ah... thank you. Why?"

"Because you would probably find it anyway. And I hope your species will... be tolerant of mine in the future."

I stayed with the Statue until it bubbled to silence.

I looked back ruefully at the hole the Xeelee had left. There went a hundred fortunes.

But, Lethe's waters could take the money. I'd take away the Statue's ship, and at least the principle of the instantaneous transmitter. That ought to be enough; resourceful creatures, we humans.

I felt Tim's presence steal over me; it was as if his hand crept into mine, reasserting our inseparability. I picked up what was left of the zap gun; it would make a great gift for him. Then I walked over fire-crisped slag to the pole.

*The Statue, that Kafka cockroach, reminded me of me. I wondered uneasily if that brave prospector would have found me as repellent, as inhuman, as the creature who tried to rob her.*

*I knew that the quantum inseparability communicator became a key enabling technology for the expansion of mankind. It made the prospector her fortune, and her fame.*

*And the expansion continued.*

*"Watch," Eve said. "Learn..."*

# The Switch

**A.D. 5066**

After the ship landed, Krupp and I made our reluctant way to the airlock. We found Ballantine already there, climbing into his neat little suit.

"Wouldn't you know it, Gorman," Krupp growled at me as he thrust his tree-trunk legs into silvered fabric. "That little bastard Ballantine always has to be first."

I searched for my helmet in a cluttered locker. "Well, it is his job, Krupp. He's the xenotechnologist... A landfall is the only time he gets to do anything useful around here."

Krupp pulled his gigantic shoulders straight. "Ask me, that creep doesn't ever do anything useful. Waste of a berth." Little Ballantine heard all that, of course. Krupp didn't care. Nor would you, I guess, if your biceps measured wider than the other guy's chest. But I thought I saw Ballantine's big-eyed face redden up just a little inside his helmet.

Captain Bayliss came stomping down the corridor. She was still rounding us all up for the EVA. Soon there were a dozen bodies, the entire crew, crammed into that airlock. Alien air whistled in and we grumbled quietly.

"Stow it!" Bayliss said irritably.

"Ah, Captain, these science stops are a waste of time," Krupp rumbled. "We're a cargo freighter, not a damn airy-fairy survey ship--"

"I said stow it," the Captain snapped. "Look, Krupp, you know the law. We're obliged to make these stops. Every time his instruments detect something like that wreck outside."

Well, we all knew who the "his" referred to. Ballantine kept his face turned to the door's scuffed metal; but his shoulders sloped a bit more.

On that ship we were all alike, all semi-skilled cargo hands. All except for Ballantine. He was the xenotechnologist the law said we had to carry.

So he wasn't exactly one of the guys.

But it wasn't his fault. I suppose we were a little hard on him -- Krupp maybe harder than most. Mind you, not so much that he deserved what he got...

The outer door slid upwards. We tumbled down the ship's ramp and spread out like an oil drop on water.

Swinging my arms with relief, I looked around. There was a double sun directly overhead, two white ovals like mismatched eggs. The sky was pinkish, washed-out. On the horizon a range of ancient hills made a splash of gray...

And in the center of the purple plain before me was the ruin of a Xeelee spacecraft. It looked like the blackened skeleton of a whale.

We moved tentatively towards it; Ballantine scampered ahead. Small fists clenched, he peered up at ribs that arched high over him. Then he dropped to his hands and knees and brushed excitedly at the dust.

Krupp came carrying Ballantine's data desk, a big trunk-sized unit that he'd propped on one wide shoulder. Captain Bayliss shook her head in disgust. "Always got to show off, haven't you, Krupp? You know that's a two-man job."

Krupp grinned, a little strain showing in his rocky face. "Aye, well, Ballantine normally does it. I just thought he deserved a break." There was a ripple of appreciative laughter. Krupp dumped the desk hard in the middle of the wreck.

Ballantine came storming up to him. "You bloody fool! You could smash something--"

Krupp considered him thoughtfully, like a biologist about to perform a dissection.

The Captain came strolling over, sending Krupp away with a simple glance. She poked one suited toe through the wreck's crumbling skin. "Seems to me there's not a lot left to smash, Mr. Ballantine," she said smoothly.

"No," Ballantine said, his breath shaking. "The Xeelee guard their technology like gold dust. When a Xeelee ship crashes, self-destruct mechanisms burn up anything that survives. But they aren't perfect. The base of this ship is intact, and there's some sort of control box down there." He pointed. "A two-way switch..."

We collected probes from the data desk and were soon crawling like muscle-bound crabs over the ship's bones. We all had our assigned tasks; with gloved fingers I poked tentatively at my Berry phase monitor, wishing I knew what it was for.

The Captain yelped in alarm. I dropped the instrument and whirled around.

Over the center of the wreck, a disc of dust as wide as a room had drifted up into the air. At its heart the data desk tumbled like an angular balloon. Captain Bayliss stood there staring, her mouth slack.

Evidently Ballantine had turned his two-way switch.

We gathered round eagerly. A working Xeelee artifact! The company paid good bounty for such things. Ballantine reached down to his switch -- it was a button set in a tiny box -- and turned it back again. The data desk fell to earth with a surprisingly hard thump; Ballantine watched thoughtfully.

The Captain cleared her throat, taking short, determined paces. "Well?"

"It's a gravity nullifier," the xenotechnologist said excitedly. He peered into instrument displays. "Above this bit of floor there was about one percent gee."

The Captain was in control again. "Gravity nullifier? Big deal. That's standard technology; got one in the ship. No bounty there, I'm afraid."

Disappointed, we turned away; but Ballantine trotted after Bayliss. "Captain, the ship's nullifier consumes gigawatts. Its central generator fills a room! This thing must work on completely new principles--"

The Captain turned on him. "Ballantine, get off my back, will you? All I care about is the schedule I've got to meet." She looked at something approaching over Ballantine's shoulder, and she smiled faintly as she continued: "If you can prise that thing out of the wreck in the next twelve hours, fine. Otherwise don't bother me." Her smile widened.

Ballantine opened his mouth to complain further -- but never got the chance. A massive arm closed around his waist and lifted him, wriggling, into the air.

The Captain just kept on grinning.

"Come on, Ballantine!" Krupp roared, carrying him to the wreck. "Let's see whether this thing of yours really works." And he flicked the switch over and held Ballantine with two hands over the gravity disc. The other men watched expectantly. "Go for it, Krupp!" Ballantine just hung there like a limp doll.

With one mighty boost, Krupp hurled the little scientist straight up.

Now Krupp is a big man. Under normal gravity he could have launched Ballantine's weight through -- what? A couple of yards?

Under one percent of gee, Ballantine soared up two hundred yards. He took about thirty seconds to drift back down; he had to tumble like a clumsy snowflake into a circle of laughing faces.

He stumbled away, brushing past me. His eyes were bright, like ice.

After ten hours we'd just about finished. Most of the men were in their cabins, cleaning up. I stood on the ship's

ramp, peering up at the eclipse of one egg-shaped star by another.

Ballantine emerged from the ship and stood with me, gazing out in silence. After a while I decided to be sociable. Lethe, we were all a long way from home. "Did you get your nullifier free from the wreck?"

He shook his head angrily. "What a waste. And it works on a completely new principle."

"Really?" I asked, already regretting opening my mouth.

"Did you know that gravity is actually made up of three forces?" he lectured. "There's the positive force Newton discovered -- and two extra, short-range forces called the Yukawa terms. Yukawa was a twentieth-century scientist.

"One Yukawa is positive and the other is negative, so they cancel each other out. Overall, two positives and a negative leave you with one positive, you see..."

His voice got higher, sharp with bitterness. I began to wonder how I could get away. "What the Xeelee artifact does is to nullify the Yukawas. The control switch has two settings. The first neutralizes the positive Yukawa, so that leaves the negative and just one positive -- nothing, to within one percent.

"But the other setting doesn't turn the device off, as I thought at first. Instead it -- neutralizes... the..."

He tailed off, staring at the wreck. Only Krupp was still out there; as a nominal penalty for his prank the Captain had set him the chore of dumping the instruments' data into the desk.

Krupp moved behind a blackened rib. Ballantine glanced at me, his face empty, then ran jerkily down the ramp towards the wreck.

Intrigued, I stayed to watch. Ballantine walked to the center of the nullifier disc and turned the two-way switch. Then he hoisted up the data desk's one percent weight and set it on his shoulder. He posed like a parody of Krupp, grinning coldly--

-- until Krupp himself came back into view. The big man stared, amazed. Then he strode up behind Ballantine and gave him a shove that sent him sprawling. The desk tumbled in the air; Krupp caught it neatly.

Ballantine hauled himself stiffly to his feet and brushed purple dust from his suit.

Krupp laughed at him. "Leave men's work to the men," he said harshly. "Turn that gravity thing off, Ballantine, and I'll carry the desk back to the ship."

Ballantine knelt and deftly turned the switch to its second setting.

Krupp gasped; his knees buckled. With a grunting effort he straightened up. I watched, bewildered. Ballantine approached Krupp and stared up into his face. "What's the matter, big man? Can't hold a little weight?"

Krupp looked as if he might drop the desk -- but while Ballantine taunted he had to stand there, legs shaking.

Something was wrong, I realized. Shouting for help I ran to the wreck; I brushed Ballantine aside and turned the switch. As the weight lifted from him, Krupp sighed. His blood-swollen face smoothed over and he fell back into the dust.

It took three of us to carry him back to the ship.

The Captain spent a long time grilling Ballantine, but she came away frustrated. What was there to find out? Krupp had hoisted one load too many, crushed a few vertebrae--

The Captain filed a report, and Krupp started to learn to use crutches.

I spent a long time thinking it all over.

We lifted off, and I found myself standing once more with Ballantine, this time at a port. We watched the planet recede. I began: "You were saying?"

His bony head swiveled towards me.



"On the ramp," I prompted. "Remember? You said that switch wasn't on-off..."

He turned away, but I grabbed one sharp-boned shoulder. "You see, I've worked it out. You said there were three gravity forces, two positive and one negative. One setting of the switch canceled out the positive Yukawa, leaving zero overall.

"But the other setting didn't switch the device off. It canceled out the other Yukawa. The negative one. And that left two positives..."

Ballantine grinned abruptly, showing crooked teeth.

I went on, "The first time you turned that switch you watched the data desk fall twice as fast as it should have done. That was your clue... And that's how you got Krupp. The data desk suddenly came down on him at two gravities..."

"I had to abandon the nullifier on the planet," he cut in harshly. "So you'll never know for sure, will you, Gorman?" His head rotated and his pale eyes locked onto mine.

I knew he was right.

I had nothing else to say. I broke the stare and walked away. Ballantine stayed at the port, teeth bared.

*The only law governing the squabbling junior races of the Galaxy was the iron rule of economics.*

*The second Occupation of the worlds of mankind was far more brutal than the first.*

*Because there were so few of them, the species called the Qax weren't naturally warlike -- individual life was far too precious to them. They were instinctive traders, in fact; the Qax worked with each other like independent corporations, in perfect competition.*

*"The Qax enslaved mankind simply because it was an economically valid proposition," Eve said. "They occupied Earth because it was so easy -- because they could. They*

*had to learn the techniques of oppression from humans themselves. Fortunately for the Qax, human history wasn't short of object lessons..."*

## **PART 3**

### **ERA: Qax Occupation**

## Blue Shift

**A.D. 5406**

Blue shift!

My fragile ship hovered over the tangled complexity of the Great Attractor. From across a billion light years worlds and galaxies were tumbling into the Attractor's monstrous gravity well, arriving so fast they were blue-shifted to the color of fine Wedgewood.

I could have stared at it all until my eyes ached. But I had a problem. Swirling round me like dark assassins' hands were a hundred Xeelee ships. They would close on me within minutes.

My hand hovered over the control that would take me home -- but I knew that the Qax, who had sent me to this fantastic place, were waiting there to kill me.

What a mess. And to think it had all come out of a sentimental journey to a breaker's yard in Korea...

Of course I should have been looking for a job before my creditors caught up with me, not getting deeper into debt with travel costs. But there I was on the edge of that floodlit pit, watching gaunt machines peel apart the carcass of a doomed spaceship.

A wind whipped over the lip of the pit. The afternoon light started to fade; beyond the concrete horizon the recession-dimmed lights of Seoul began to glow. It was a desperate place. But I had to be there, because what they were breaking that day was the last human-built spacecraft. And my life...

A shadow moved over the pit; workmen paused and looked up as the mile-wide Spline ship drifted haughtily

past the early stars. There was a Spline ship looming over every human city now, a constant reminder of the power of the Qax -- the ships' owners and our overlords.

The shadow moved on and the wrecking machines worked their way further into the ship's corpse. Finally, after three centuries of Occupation, the Qax had shut down human space travel. The only way any human would leave the Solar System in the future was in the alien belly of a Spline. I began to think about finding a bar.

"Like watching the death of a living thing, isn't it?"

I turned. An elegant stranger had joined me at the pit's guard rail. Gray eyes glittered over an aquiline nose, and the voice was rich as velvet.

"Yeah," I said, and shrugged. "Also the death of my career."

"I know."

"Huh?"

"You're Jim Bolder." The breeze stirred his ash-tinged hair and he smiled paternally. "You used to be a pilot. You flew these things."

"I *am* a pilot. I don't know you. Do I?" I studied him warily; he looked too good to be true. Did he represent a creditor?

He spread callus-free palms in a soothing gesture. "Take it easy," he said. "I don't want anything from you."

"Then how do you know my name?"

"I'm here to make you an offer."

I turned to walk away. "What offer?"

"You'll fly again."

I froze.

"My name's Lipsey," he said. "My... clients need a good pilot."

"Your clients? Who?"

He glanced about the deserted apron. "The Qax," he said quietly.

"Forget it."

He exhaled sadly. "Your reaction's predictable. But they're not monsters, you know--"

"Who are you, Lipsey?"

"I... was... a diplomat. I worked with a man called Jasoft Parz. I helped negotiate our treaty with the Qax. Now I try to do business with them."

I stared at him, electrified.

The Qax, during the long Occupation, had withdrawn Anti-Senescence technology. Death, illness, had returned to our worlds.

If he remembered Jasoft Parz, Lipsey must be centuries old. Unlike the rest of Occupied mankind, Lipsey was AS-preserved.

He saw the look on my face.

"I know it's hard to sympathize, but I believe we have to be pragmatic. They're just like us, you see. Looking out for number one, scrabbling for Xeelee artifacts--"

I jammed my hands in my pockets and turned away once more. "Maybe, but I don't have to fly one of their damn Spline ships for them."

"You don't fly a Spline ship. Such strong opinions, and you don't even know that? Spline ships fly themselves."

"Then what's the ship? Squeem?"

"Xeelee," he said softly. "They want you to fly a Xeelee ship." He smiled again, knowing he'd hooked me for sure.

"I don't believe you," I said.

Lipsey shrugged, turning his face from the rising breeze. "The Xeelee fighter was found derelict -- a long way from here. The Qax paid well for it."

I laughed. "I'll bet they did."

"And they'll pay you well for flying it."

"Prove it exists."

Furtively he dug inside his coat of soft leather and produced a plastic-wrapped package. "This was found aboard," he said. "Take a look."

I peeled back the packaging. Inside was a delicate handgun sculpted from a marblelike material. The butt was wrapped in a hair-thin coil. Fine buttons were inlaid into the barrel, too small for human fingers.

"Xeelee construction material." Lipsey's gray eyes were fixed on my face. "Controls built to the Xeelee's usual small scale."

"What is it?"

"We don't know. There is synchrotron radiation when the thing's operated at its lowest power setting, so the Qax think the coil around the butt is a miniature particle accelerator. They haven't had the courage to try the higher settings." His face lit up briefly at that. He put away the artifact and pulled his coat tight around him. "The ship's in orbit around the Qax home sun. The Qax will tell you the rest when you get there. I've a flitter waiting at Seoul spaceport; we can leave straight away."

"Just like that?"

He studied me with a frank knowledge. "You have someone to say goodbye to?"

"...No. I guess you know that. But tell me one thing. Why don't the Qax fly the damn ship themselves?"

He stared at me. "Have you ever seen a Qax?"

A million years ago the race we call the Spline made a strategic decision.

They were ocean-going at that time, great whalelike creatures with articulated limbs. They'd already been space travelers for millennia.

Then they rebuilt themselves.

They plated over their flesh, hardened their internal organs... and left the surface of their planet, rising like mile-wide, eye-studded balloons. Now they're living ships, feeding patiently on the thin substance that drifts between the planets.

Since then they've hired themselves out to fifty races, including the Qax; but since they're not dependent on any one world, or star, or type of environment, they're their own masters -- and always will be.

But there are drawbacks... mostly for their passengers.

Our cabin was a red-lit hole scooped out of the Spline's gut. Our journey to the Qax home world meant three days in that stinking gloom. It was like being swallowed.

As a precondition of accepting our commission, the Spline sold us each an emergency beacon. It was a sort of limp bracelet. "It's a quantum-inseparability beacon. You work it by squeezing its mid-portion," Lipsey said. "The Spline guarantee your rescue, anywhere within the Galaxy. Of course, the price of the rescue's negotiable. Higher if you don't want the Qax to know about it."

"I don't want this."

He shrugged. "Have it on credit. You might need it one day."

"Maybe." I wrapped the bracelet around my wrist; it nestled into place like a living thing.

Disgusting. I missed human technology.

We entered orbit around the Qax planet.

Our air and water were re-absorbed by the cabin walls, then an orifice dilated and we passed through a bloody tube to space. The stars were clean and cold. I breathed freely for the first time since we'd left Earth.

Lipsey's two-man flitter was extruded from another sphincter, and we spiraled over the Qax world. Under the murky atmosphere I saw a planet-wide ocean. Submerged volcano mouths glowed like coals. There were no cities, no lights. "It's a goddamn swamp," I concluded.

Lipsey nodded cheerfully, intent on his inexperienced piloting. "Yes. It's like the primeval Earth."

"So where are the Qax? Undersea?"

"Wait and see."



We landed and stepped out onto a spaceport, a metal island in a bubbling quagmire. Steam misted up my face plate. Lipsey lifted a suitcase-sized translator box down from the flitter. "Meet our client," he said.

"Where?"

He smiled. "Here! All around you."

The translator box woke up. "This is the human pilot we discussed?"

I jumped, whirled around. Nothing but swamp.

"Yes," said Lipsey, his tone deep and reassuring. "This is Jim Bolder."

"And this is really one of your best?" boomed the Qax.

I bristled. "Lipsey, what is this?"

He smiled, then stood beside me and pointed. "Look down there. What do you see?"

I stared. "Turbulent mud." Hexagonal convection cells a hand's breadth across, quite stable: the ocean was like a huge pan of boiling water.

Lipsey said: "All known forms of life are based on a cellular organization. But there are no rules about what form the cells have to take..."

I thought it over. "You're telling me that those convection cells are the basis of the Qax biology?"

I stared at the sea, trying to perceive the limits of the mighty creature. I imagined I could see thoughts hopping over the rippling meniscus like flies...

"Can we proceed?" the Qax broke in. The box gave it an appropriate voice: deep-bellied, like an irritable god.

I tried to concentrate. "Show me the Xeelee ship," I said.

"In time. Do you know what we want of you?"

"No."

"What do you know of galactic drift?" the Qax began. "Your astronomers first detected it in your twentieth century..."

The galaxies are streaming.

Like a huge liner our Galaxy is soaring through space at several hundred miles a second. That's maybe no surprise -- until you learn that all the other galaxies, as far as we can see in any direction, are migrating, too. And they're all heading for the same spot.

Standing there on that shiny island in a mud sea, I struggled with the scale of it all. Throughout a sphere a billion light years wide, galaxies are converging like moths to a flame.

But what is the flame? And -- who lit it?

"We call it the Great Attractor," said the Qax. "We know something about its properties. It is three hundred million light years from here. And it's massive: a hundred thousand times the mass of our Galaxy, crammed into a region about half the Galaxy's diameter."

A cold mist settled over us; the Qax restlessly stirred its oceanic muscles. I felt like a flea on the back of a hippopotamus.

"We need to understand what is happening out there," the Qax went on. "Now: we have trading contacts throughout the Local Cluster, and we've been analyzing sightings of Xeelee ships. We had the idea of trying to track down the Xeelee Prime Radiant -- their source and center of activities. We have done so."

"The Prime Radiant is at the center of the Galaxy," I said.

Lipseley smiled thinly. "You're not thinking big enough, Bolder. The Xeelee transcend any one Galaxy."

I thought that through... and my mouth dried up. "You're not suggesting," I asked slowly, "that the Xeelee are responsible for the Great Attractor? That they're *building* it?"

"We plan to send a probe to find out," said the Qax. "Our captured Xeelee ship is the technology we need to cross such distances."

"Which is where I come in?"

"Do you accept the commission, Bolder?"

"Yes," I said immediately, staring fixedly at the translator box. To fly a Xeelee fighter to the center of everything... my only fear now was that I'd be turned down.

Lipseley interrupted smoothly: "Subject to a suitable fee, of course." He smiled like a good agent.

Surrounded by the primeval murk, we began discussing powers of ten.

We returned to Lipsey's flitter.

"Lipseley... why do the Qax care? What turns them on?"

"Short-term profit," he said simply. "This is a young planet, not all that stable. Hot spots come and go, and individuals tend to be broken up quickly.

"As a result they don't have a strong sense of self, and they find it hard to plan for -- or even imagine -- the future." His face creased with wonder. "There are only a few hundred of them, you know, each of them miles across... but thanks to their peculiar biology their awareness and material control go right down to the molecular level. They've developed a high, miniaturized technology; it's the basis of their commercial power. Of course," he smiled, "they trade by proxy."

I frowned. "We're millions of years from a crisis over this Great Attractor. If they're so shortlived, why spend so much on gathering data about it?"

"Profit. With a secret as big as this they can name their own price."

We rendezvoused with a Spline craft, orbiting the Qax star. The Spline was a gunship. We scurried around huge walls covered with thirty-foot-wide scales, and I peered curiously into hundreds of weapon emplacements -- and then, drifting through the Spline's long shadow, we found the Xeelee ship.

A Xeelee nightfighter is a hundred-yard sycamore seed wrought in black. The wings sweep back from the central pilot's pod, flattening and thinning until at their trailing edges they are so fine you can see the stars through them.

Lipsev caught me gawping. "Save it. You've seen nothing yet..."

The pilot's pod was an open framework about my height. A human crash couch had been cemented inside it. I clambered through the skeletal hull and into the couch. The hull became a mesh of blackness around me that barely excluded the stars. "Kind of open," I said.

Lipsev, watching from outside, laughed a bit unsympathetically. "Evidently the Xeelee don't suffer from vertigo. Do you?"

I clamped the translator box to a strut above my head. Now the Qax spoke. "Study your controls, Bolder."

"Right." Set ahead of me and to my sides were three control panels, each briefcase-sized. Magnifying monitors showed me sequinlike control studs. Waldoes would let me work the panels by my sides, but there was no waldo for the third.

"The panels to your sides are for in-system flight," said the Qax. "The third, before you, is for the hyperspace drive. The three panels were the only equipment found in this ship -- apart from the synchrotron handgun."

"I'm not getting that back?"

"The Qax think you're dangerous enough as it is," Lipsey said quietly.

The Qax continued: "We've worked out a setting to take you out to the Great Attractor. Just hit the red button, on the left of the third panel. Hit it again to come home."

I ran a gloved finger over the surface of the third panel. Apart from the red button the panel was half-melted... unusable. I asked why.

"Of course," the Qax explained acidly, "you'd never be tempted to steal a treasure like this, but..."

I slipped my hands into the waldo manipulators. The ship woke up. "So tell me how I fly this thing."

The wings of the sycamore seed billowed out, a shaken blanket a hundred miles wide.

"The motive force comes from the structure of space itself," the Qax explained. "The wings are sheets of discontinuity in space. The -- healing up -- of space drives the ship forward."

I squeezed minutely. The wings trembled and the pod jerked. Lipsey and his flitter disappeared. "Try to restrain your monkey impulse to meddle," said the Qax. "You've just traveled half a light second."

I let go, fast.

"Now," said the Qax. "A controlled pressure with your right index finger..."

All I've ever wanted to do is fly. I've given up everything else in life for it, I suppose... and now my wings pulsed like sheets of shadow as I flew around the Qax star at half the speed of light. I stared into the eye of a vacuole and, whooping, whizzed under the blue-shifted arch of a stellar flare.

Blue shift! I was traveling so fast that light itself seemed as sluggish as the Doppler-shifted noise of a passing train.

The Qax gave me my head. Probably the ship was fairly immune to accidents... even if I wasn't.

"The Xeelee hyperdrive works on unconventional principles," the Qax told me. "On your return, we're not sure precisely where in our system you'll arrive -- but we know it will be a fixed distance from the sun.

"The mass of the ship and sun are the deciding factors. The more mass the ship has, the closer to the sun you'll be placed."

I flew out to that critical return orbit. I wasn't surprised to find a Spline gunship, pitted with weapons that tracked me like eyes. Around the curve of the orbit was another

gunship, and another. I swept out of the ecliptic plane, only to find more gunships. The Qax sun was encased by a sphere of them, completely staking out my return radius. "This must be costing you a fortune," I said. "Why?"

Lipsev said elegantly: "Oh, they're not scared of you, Bolder. But they wouldn't like a hundred armed Xeelee to come swarming out of that ship instead of you, now would they?"

After two months' training I felt ready. I skimmed out to the Spline-guarded radius and closed up my wings. Lipsey, once more alone with the Qax, said gently: "Good luck, Jim Bolder."

"Yeah." I hit the red button--

-- and gasped as the hyperdrive jump made the Qax sun wink to nothingness. Below my feet appeared a compact yellow star, set in a sky crowded with stars and dust. I became aware of a trickle of clicks and pops as instruments clustered around me began to study the hurtling wonders.

"Wow!" I said.

"Bolder," said the Qax, "skip the epithets and report."

"I think I'm near the center of the Galaxy."

"Good. That is--"

-- another jump--

" -- according to plan."

"Lethe." The yellow sun had disappeared; now I hovered below a dumbbell-shaped binary pair. Great tongues of golden starstuff arced between the twin stars. The sky was darker; I must be passing through the Galaxy and out the other side--

-- jump--

-- and now I was suspended below the plane of the Galaxy itself; it was a Sistine ceiling of orange and blue, the contrasts surprisingly sharp--

-- jump--

-- and these jumps were coming faster; I watched a dwarf star scour its way over the surface of its huge red parent and that dim disc over there must be my Galaxy--

-- jump--

-- and now I was inside a massive star, actually within its pinkish flesh, but before I could cry out there was another--

-- jump--

-- and--

-- jump -- jump -- jumpjumpjumpjump--

I closed my eyes. There was no inward sensation of motion; only a flickering outside my eyelids that told me of skies being ripped aside like veils.

"...Bolder! Can you hear me? Bolder--"

I took a breath. "I'm okay. It's just -- fast." I risked another look. I was passing through a frothy barrage of stars and planets; beyond them sheets of galaxies moved past as steadily as roadside trees. I said slowly: "I must be making a megalight, or more, an hour. At this rate the journey will take about two weeks--"

"Yes," Lipsey said. "We think the Xeelee have a range of hyperdrive capabilities. The standard intragalactic version is limited to a kilolight an hour, or thereabouts. Whereas this more powerful intergalactic model--"

I tumbled into the creamy plane of an elliptical Galaxy. I wailed and closed my eyes again.

Ten days later, the popping stars no longer bothered me. I guess you can get used to anything. Even the growing gray patch ahead of me -- a cloud of objects around the Great Attractor -- seemed less important than the itchy confines of my suit. In fact, I felt fine until a disc of sky directly behind me turned china blue...

"I don't get it," I said. "Objects that I'm leaving behind should be redshifted."

"It's nothing to do with your motion, Bolder," the Qax explained. "The blue shift is gravitational. You're now close

enough to the Great Attractor that light from the outside Universe is beginning to fall more steeply down its gravity well."

I checked my instruments. "But that's ridiculous... I'm still millions of light years away."

The Qax didn't bother to respond.

Two more days. The light became a hail of hard blue as it plummeted after me into this pit in space. I entered the outskirts of the mist around the Great Attractor; it resolved into individual stars and what looked like bits of galaxies.

The muddled starlight bathing my cage began to flicker. I felt my heartbeat rising. The skies riffled past me like the pages of a great book, ever slower. Finally the ship stuttered to a halt.

"I've arrived," I whispered. "I'm still inside the star mist." I looked around, clutching the arms of my couch. "I'm in orbit around what looks like a small G-type star. But the sky's crammed with streaming stars, hundreds of them close enough to show discs. It's blue-tinted chaos.

"And -- I can see something ahead. A bank of light beyond the mist." My breath caught at the sheer scale of it all. "That's the Great Attractor, right?"

"Don't touch your controls until we tell you, Bolder," the Qax murmured.

"What? Why not?"

"You've got company. To your left..."

A hoard of night-dark ships came soaring away from the Great Attractor and out into the star cloud. There were small fighters like mine, swirling in flocks like starlings. And here and there I saw cup-shaped freighters miles wide, cruising like eagles.

The sky was black with ships.

"Xeelee," I breathed. "There must be millions of them. Well, you were right, Qax... But I don't believe in coincidence. I haven't stumbled across the only Xeelee fleet in the area. This star cloud must be swarming with them."



"Follow them," said the Qax.

"What?"

"Activate your drive. You're a lot less likely to be noticed as one of a flock than as an individual."

"...Yeah." I spread my wings and banked sideways into the flock. Soon I was waddling along, a self-conscious duck among swans. Inside the waldoes my sweating fingers began to cramp up with the effort.

The fleet was heading for a young star. Through the crowd ahead of me I could see the star's disc, its violet light diamond-hard. As we neared the star the torrent of ships abruptly splashed sideways, as if encountering an invisible shield. When I reached the breaking radius I banked left and set off after the herd.

Twenty hours after my arrival the Xeelee completed their formation. With wings folded like patient vultures they completely surrounded the star.

"What now?" I asked uneasily.

"No doubt we'll find out."

I wished I could rub my gritty eyes. "Qax... I haven't slept since coming out of hyperspace, you know."

"Take a stimulant."

Sudden as an eye blink, bloodred threads of light snaked into the star from every ship in the fleet.

Well, from every ship except one. Mine.

It was a poignant sight: a stellar Gulliver, pierced by a million tiny arrows. The star's light flickered, oddly. And I became aware of a stirring in the ranks of the Xeelee nearest me.

"They're starting to notice me," I whispered. "How do I turn on my beam?"

"You don't," said Lipsey. "Remember that Xeelee handgun? This must be what happens at the highest setting."

A purple arch of tortured gas erupted from the star. Soon flares covered the star's surface; clouds of ejecta

drifted through the cherry-red beams. Cup freighters moved in, placidly swallowing the star flesh.

It was like watching the death of a magnificent animal. "They're destroying it," I said. "But how?"

"The handgun must be a gravity wave laser," the Qax said slowly. "The coils on the butt of that handgun are small synchrotrons. Subatomic particles move at fantastic velocities in there; the thing emits a coherent beam of gravity waves which--"

"I thought you needed large masses to get significant gravity waves."

"No. As long as you move a small mass fast enough... the energy must come from the same source as your ship's -- from the structure of space itself."

"Handguns to break stars, eh?"

A shadow moved across my vision. I glanced about quickly. A dozen Xeelee slid across the blue-shifted sky and gathered into a close sphere around me.

"They've noticed me." Rapidly I thought over my options. Before me was the reassuring red glow of the hyperspace button: my escape hatch, if things got too hot... but, I quickly decided, I'd come too far to go home without seeing the Great Attractor itself.

I spread my wings as far as they would go and dragged them downwards in one mighty swoop. I shot head first out of the closing trap and kept going, heading deeper into the blue-tinged star cloud. My breath was loud in my helmet.

"What now?" I gasped.

"Run!" said Lipsey.

I ran for hours. I dodged stars only light minutes apart, their surfaces distorted into surreal shapes by their proximity to each other. The bank of grayish light beyond the mist grew remorselessly brighter and wider -- and all the time the Xeelee formation was a spear pointing at my shoulderblades.

At last, abruptly, I burst out of the star mist. The naked light ahead was dazzling. Heart thumping, I wrenched at the wings and skidded to a halt. I found myself in a region clear of stars and debris... and the curtain of stars on the other side was tinged blue.

So I was at the center. The bottom of the pit; the place all the stars were falling into. And at the heart of it all, flooding space with a pearly light, was the Great Attractor itself.

It was a loop, a thing of lines and curves, a construct of some immense cosmic rope. My nightfighter was positioned somewhere above the plane of the loop. The near side of the construct formed a tangled, impenetrable fence, twisted exuberantly into arcs and cusps, with shards of galaxy images glittering through the morass of spacetime defects. And the far side of the object was visible as a pale, braided band, remote across the blue-shifted sky.

And it was -- astonishingly, unbearably -- a single object, an *artifact*, at least ten million light years across.

The rough disc of space enclosed by the artifact seemed virtually clear.

...Clear, I saw as I looked more carefully, save for a single, glowing point of light, right at the geometric center of the loop.

"Qax," I croaked. "Speak to me."

"A massive rotating toroid," murmured the Qax. "A made thing, of cosmic string. The Xeelee have manipulated one-dimensional space-time discontinuities, just as -- in their night-fighter intrasystem drive -- they manipulate two-dimensional discontinuities."

Lipsey said, "I didn't imagine anything like this. A ring, an artifact of cosmic string. As large as a giant galaxy. The audacity..."

"But -- why? What's the point?"

The Qax paused. "Well, this fits one of our hypotheses. Look in the central region, Bolder."

The hole in the ring hurt my eyes. It was a sheet of space that was somehow -- tilted. I saw muddled space, stars streaked like cream in coffee.

"Do you know about the Kerr metric?" asked the Qax. "No? The Great Attractor is a massive toroid rotating extremely quickly. Your own theory of relativity predicts some odd effects with such a structure. There may be closed lines in space and time, for instance--"

"Come again?"

"Time travel," said Lipsey. "And more... Bolder, the Kerr metric describes Interfaces between Universes. Do you understand? It's as if--"

"What?"

"As if the Xeelee don't like this Universe, so they're building a way out."

I focused my monitors on the dust that walled the cavity in the stars. I saw ships -- an aviary of all shapes and sizes, uncountable trillions of them.

A few light minutes from me I made out a particularly monstrous ship, a disc that must have been the size of Earth's Moon. Hundreds of cup freighters nestled into neat pouches in the disc's upper surface, dumping out stolen star material. Vents in the underside of the main ship emitted a constant rain of immense crystalline shafts, as if it were some huge sieve leaking rainwater.

Peering deeper into the mist of craft I could see fantastic bucket-chains of the disc-ships descending to the Great Attractor, dwindling to pinpoints against the vast carcass of the ring. Returning ships, I saw, were diverted to clouds of cup freighters for reloading.

I began to see the pattern. "So the disc-ships are huge, ah, dumper trucks," I said. "They're tending the Great Attractor, bringing it matter and energy. Using that

crystalline stuff to grow the string, knitting it together strand by strand, with a patience that's lasted billions of years..."

There was a flicker in my peripheral vision. My posse. They whirled around me and began to close up once more.

I closed up my wings and prepared to punch the red button. "Lipse, I've seen enough. We've got to spread this news around all the races in our region -- find a way to stop the Xeelee before they wreck our Universe. We've time to plan--"

He coughed apologetically. "Ah -- look, Bolder, this information is Qax commercial property. You know that."

I hesitated. "You're kidding. We're doomed if the Qax keep this knowledge to themselves."

He sighed. "The Qax don't think on those timescales. They can't, remember. They think about profit, today."

I forced my hand away from the escape button; a cold knot in my stomach started to tighten. Suddenly this wasn't a game. If I tried to go home after what I'd just blurted out, the Qax wouldn't hesitate to use their Spline warships to blast me out of the sky. Abruptly my isolation telescoped into a vivid reality, and the cage around me seemed absurdly fragile... And the Xeelee whirled tighter, reminding me that hanging around here wasn't an option either.

I had to find more time. To my right, obscured now by the fog of fighters around me, was that dumper truck with its attendant freighters. I opened up my wings, clutched at space and lurched out of the trap. Soon I was thrusting my way into the crowded freighter formation, my wings tucked tight. The fighters blurred after me.

I rammed thoughts through my sleep-starved brain as I flew. Could I evade the waiting Spline? Maybe I could divert the ship's hyperspace flight -- but how? Prise open the melted control box? Change the ship's mass, to change the distance I arrived from the Qax sun?

Of course I could abandon ship before I reached the Qax system, at one of the later jump points. I had that Spline emergency beacon; I'd be picked up. And if I kept quiet I could hide from the Qax, for years maybe...

But, damn it, if I did that humanity and a few hundred other races would one day end up falling into the Xeelee pit. Hiding wasn't good enough.

I dipped under the lip of the dumper truck and dodged the processed Great Attractor material sleeting from the truck's base. The huge icicles fell a few thousand miles and then broke up into a fine mist... and as I stared abstractedly at that mist I realized there was a way out of this. It was stupid, crazy, nearly unworkable. And my only chance.

"All right, Qax," I said. "I'll come home. But first..."

I dropped, spread my wings as far as they would go and whirled like a seagull through the crystal rain. The wings plated over rapidly and grew stiff and cumbersome.

"Bolder, what are you doing?"

"Wrecking this beautiful ship," I told Lipsey with real regret.

The Xeelee fighters finally closed around me, shutting out the rain.

I pressed the button.

The Xeelee trap disappeared; I'd jumped back to the blue-tinged light of the star cloud. And then--

Jump. Jump. Jump -- jump -- jump -- jumpjumpjump--

The skies became a blur. I slumped into sleep.

I fell towards the welcoming pool that was my home Galaxy. I peered out of my glazed-over cage as the stars' flickering began to slow. For the first time in a month I unbuckled the straps that bound me to my couch, and prized the translator box free of the strut over my head.

Lipsey and I said our goodbyes. "Do me a favor," I said. "Whatever happens, keep talking. Tell me what you see."

"Whatever you say." I imagined his noble face gazing out over the seething Qax ocean. "Bolder... I want you to know I'm sorry."

"Yeah." The ship -- jumped -- to the dumbbell binary system. It was dazzling; I'd arrived much closer than I remembered from my visit on the way out. I bunched a gloved fist in triumph. This was going to work--

-- jump--

A compact yellow star at the heart of the Galaxy, searingly close to the ship. Last stop. Time to get out.

I climbed onto my seat, put my shoulders against the pod's crystalline plating, and pushed. For a heart-stopping moment I thought the shell was too strong -- then it crumbled, and I popped into space, clutching my translator box. Below me glittered the crusted wings of the ship I'd taken so far.

My plan had worked. The Great Attractor substance had added enough mass to the ship to shift its arrival point significantly closer to the system center. Now I had to rely on the Qax to do the rest--

-- jump--

-- and the ship disappeared and I was left alone in a cloud of fragments; they sparkled in the light of the compact star.

I drifted there for a while, rotating slowly. Then I squeezed the Spline distress bracelet. It turned rigid and cold.

Lipsey began to speak out of the translator box. His voice was hoarse, forced. I listened, absently picking sparkling fragments out of the space around me and stuffing them into a suit pocket.

"You haven't come out where we expected, Bolder. What have you... you're causing the Qax a lot of confusion, I can tell that much..."

A pause. "I think they've found you... but what are you doing there?"

The Spline warships rotated like eyeballs, scouring space...

Then they found my ship, inexplicably close to the Qax sun.

The Qax panicked. They sent their shell-shaped armada roaring in towards their sun. Waves of energy pounded the Xeelee ship; the great wings sagged like melting chocolate. And in the middle of that torrent of energy was a thread of cherry-red light that arrowed through the wreck and into the sun.

As I'd hoped, in their anxiety and confusion the Qax had thrown at my ship all they had -- including their only Xeelee weapon.

Of course, it was only a single starbreaker. I'm told it took a couple of days before the flares started.

Lipseley died alone, surrounded by the rage of humanity's conquerors. It was the end of an undeservedly long life. But he died laughing at them. I heard him.

A Spline freighter ingested me after a day.

The Spline sold me access to a human news channel. I figured, why not. Since I was still broke, in spite of everything, I wasn't going to be able to pay them anyway...

Humanity was rejoicing. Qax-owned ships were disappearing from the skies of the human worlds of the Solar System. The Qax were going to need every cubic foot of carrying capacity to get themselves off their home world before their sun blew up. They were going to be busy for a long, long time, and much too preoccupied to hunt me down.

And once I released my news about the Xeelee, we'd be busy, too. One day we'd go back to the Great Attractor, take on the Xeelee starbreakers.

But in the meantime I'd have to find a job. My adventure was over and I faced the dreary prospect of spending the rest of my life paying off the Spline -- among others. I



reached for my suit and dug out my handful of Great Attractor fragments. Cold as ice, and just as worthless, they sparkled even in the Spline's blood-tinged light--

Worthless?

Suddenly I imagined these stones set in platinum and resting against tanned flesh: Xeelee-made gems from half a billion light years away.

Maybe I had a way to pay off my debts after all. Soon, AS technology would be available again. And after that I could buy my own ship, start a small line...

I put away the stones and began to dream again.

*Eve said, "Jim Bolder was a brave, impulsive man. But he thought big. He immediately saw the significance of the knowledge of the Xeelee artifact, the thing he called the Great Attractor, to mankind.*

*"Bolder lived for the moment. But his actions would resound through millions of years. It is entirely appropriate that, for humans, the artifact he found would always bear his name:*

*"Bolder's Ring.*

*"But the impact of his actions on the Qax was devastating..."*

*The pathetic Qax evacuation armada consisted of hundreds of Spline ships.*

*The craft, their spherical hulls open, settled into the Qax ocean. Each hull was lined with heaters designed to simulate the volcanism of that mother sea; convection cells were stirred to life inside the ships, and the awareness of a Qax slid reluctantly aboard each craft.*

*The Spline carriers lifted cautiously from the amniotic ocean. Flares like human fists already punched out of the sun, and gales howled through the atmosphere, buffeting the stately rise of the Spline. With each jolt the delicate*

*convection patterns were disrupted; the Qax endured the gradual paring away of their awareness.*

*Over half the race expired.*

*But after the evacuation, the inventiveness and enterprise of the Qax were reasserted. Soon traders were once more spreading Qax goods and services through the neighboring star systems. And the Qax, adrift in their Spline fleet, began to explore new homes for their delicate structures.*

*They were creatures of turbulence, and they found turbulence everywhere.*

*Qax awareness took root in the roiling air of Jovians... in the slow, stately gravitational rhythms of galactic orbits... and at last they learned how to colonize the structure of seething space itself.*

*On their reemergence as an interstellar power the Qax sought out humanity, but -- as Bolder in his blundering way had evidently hoped -- the Qax's long, forced withdrawal from affairs had given mankind time to grow powerful.*

*The history of the two species diverged, with humanity resuming its vigorous expansion, and the Qax beginning an introspective retreat into the structure of space.*

*Soon the Qax were numberless, and had become immortal.*

*But they remembered the moment at which a single human being had brought them to the brink of extinction.*

*Meanwhile, humans prospered.*

*Some argued that access to Xeelee technology damaged human inventiveness. It was too easy to take rather than build.*

*But not all exploration was finished. And, in the course of that exploration, evidence was unturned -- fragmentary and incomplete -- of a technology even older than the Xeelee...*

# The Quagma Datum

**A.D. 5611**

The soup was cold. I pushed it away. "Tell me why I'm here."

Wyman didn't answer until the next course arrived. It was a rich coq au vin. He forked it into his mouth with an enthusiasm that told me he hadn't always been accustomed to such luxury. Earthlight caught the jewelry crusted over his fingers.

Faintly disgusted, I lifted my eyes to the bay window behind him. Now that we'd left the atmosphere the Elevator Restaurant was climbing its cable more steeply. The Sahel ground anchor site had turned into a brown handkerchief, lost in the blue sink of Earth.

Suddenly the roof turned clear. Starlight twinkled on the cutlery and the table talk ebbed to silence.

Wyman smiled at my reaction.

"Dr. Luce, you're a scientist. I asked you here to set you a scientific puzzle." His accent was stilted, a mask for his origins. "Did you read about the lithium-7 event? No? A nova-bright object fifteen billion light years away; it lasted about a year. The spectrum was dominated by one element. Doctor, the thing was a beacon of lithium-7."

A floating bottle of St. Emilion refilled my glass.

I thought about it. "Fifteen billion years is the age of the Universe. So this object went through its glory soon after the Big Bang."

Thin fingers played with coiffed hair. "So, Doctor, what's the significance of the lithium?"

"Lithium-7 is a relic of the early Universe. A few microseconds after the singularity the Universe was mostly

quagma -- a magma of free quarks. Then the quarks congealed into nuclear particles, which gathered into the first nuclei.

"Lithium-7 doesn't form in stars. It was formed at that moment of nucleosynthesis. So all this points to an early Universe event."

"Good," he said, as if I'd passed a test.

Our empty plates sank into the table.

"So what's this got to do with me? I hate to disappoint you, Wyman, but this isn't my field."

"Unified force theories," he said rapidly. "That's your field. At high enough energies the forces of physics combine into a single superforce. The principle of the old GUTdrive. Right? And the only time when such energy densities obtained naturally was right after the Big Bang. The superforce held together your quagma." He was a slight man, but the steadiness of his pale eyes made me turn aside. "So the early Universe is your field, after all. Dr Luce, don't try to catch me out. You think of me, no doubt dismissively, as an entrepreneur. But what I'm an entrepreneur of is human science. What's left of it... I've made myself a rich man. You shouldn't assume that makes me a fool."

I raised my glass. "Fair enough. So why do you think this lithium thing is so important?"

"Two reasons. First, creation physics. Here we have a precise location where we can be certain that something strange happened, mere moments after the singularity. Think what we could learn by studying it. A whole new realm of understanding... and think what an advantage such an understanding would prove to the first race to acquire it."

"And what profits could be made from it," I said dryly. "Right? And the second reason?"

"The Silver Ghosts think it's important. And what they're interested in, I'm interested in."

That made me cough on my wine. "How do you know what the Ghosts are up to?"

His grin was suddenly boyish. "I've got my contacts. And they tell me the Ghosts are sending a ship."

I choked again. "Across fifteen billion lights? I don't believe it."

"It's a fast ship."

"Yeah..." I thought it through further. "And how could such a ship report back?"

Wyman shrugged. "A quantum-inseparability link?"

"Wyman, the attenuation over such distances would reduce any data to mush."

"Maybe," he said cheerfully. "In conversational mode anyway. I hear the Ghosts are planning a high-intensity packet burst device. Would that get through?"

I shrugged. "Perhaps. You still haven't told me why you're talking to me."

Abruptly he leaned forward. "Because you've the expertise."

I flinched from his sudden intensity.

"You've no family. You're fit. And the youthful idealism that trapped you in research has long worn off -- hasn't it? - now that your contemporaries are earning so much more in other fields. You need money, Doctor. I have it."

Then he sipped coffee.

"I've the expertise for what?" I whispered.

"I've got my own ship."

"But the Ghosts--"

He grinned again. "My ship's got a secret... a supersymmetry drive. The Susy drive is a human development. A *new* one, can you believe it? The Ghosts don't have it. So my ship's faster, and we'll beat them."

"For Lethe's sake, Wyman, I'm an academic. I've never even flown a kite."

A cheese board floated by; he cut himself precise slices. "The ship will fly itself. I want you to observe."

I felt as if I were falling. I tried to think it out. "...Tell me this, Wyman. Will there be any penalty clauses in my contract?"

He looked amused. "Such as?"

"For not getting there first."

"What's going to beat the Susy drive?"

"A Xeelee nightship."

Expressions chased across his face.

"All right, Doctor. I accept your point. The Xeelee are one of the parameters we have to work within. There'll be no penalty clauses."

Above my head the Restaurant's geostationary anchor congealed out of starlight into a mile-wide cuboid.

"Now the details," Wyman said. "I want you to make a stop on the way, at the home world of the Ghosts..."

Wyman's "ship" was a man-sized tin can.

It was stored in an open garage on the space-facing side of the Elevator Anchor. The thing's cylindrical symmetry was broken by strap-on packages: I recognized a compact hyperdrive and an intrasystem drive box. Set in one wall was a fist-sized fusion torus.

Wyman pointed out a black, suitcase-sized mass clinging to the pod's base. "The Susy drive," he said. "Neat, isn't it?"

I found half the hull would turn transparent. The interior of the pod was packed with instrument boxes, leaving precious little room for me.

I studied the pod with mild distaste. "Wyman, you expect me to cross the Universe... in this?"

He shrugged delicately. "Doctor, this is the best my private capital could fund. I've not had a cent of support from any human authority. Governments, universities, so-called research bodies... in the shadow of the Xeelee

mankind is suffering a failure of imagination, Luce. We live in sorry times."

"Yeah."

"And that's why I've set up a meeting with the Ghosts on the way out. This flying coffin isn't much, but at least it demonstrates our intent. We're going for the prize. Perhaps it will persuade the Ghosts that we should pool our resources."

"Ah. So this pod is really a bargaining counter... you don't mean it to make the journey after all?" I felt a mixture of relief -- and profound regret.

"Oh, no," Wyman said. "What I told you is true. I sincerely believe the Susy drive could beat the Ghosts to the prize. If necessary. But why not spread the risk?" He grinned, his teeth white in the gloom of his helmet.

I left a day later.

Our Universe is an eleven-dimensional object. All but four of those dimensions are compactified -- rolled up to an unimaginable thinness. What we call hyperspace is one of those extra dimensions.

The hyperdrive module twisted me smoothly through ninety degrees and sent me skimming over the surface of the Universe like a pebble over a pond.

Of course, I felt nothing. Hyperspace travel is routine. With the pod's window opaqued, it was like riding an elevator. I was left with plenty of time to brood. When I checked the pod's external monitors I could see the Susy-space module clinging to the hull, dormant and mysterious.

After five days, with a soft impact, the pod dropped back into four-space.

I turned on my window. I was rotating slowly.

The sun of the Silver Ghosts is in the constellation of Sagittarius. Now it slid past my window, huge and pale. I could see stars through its smoky limb. Something came

crawling close around that limb, a point of unbearable blue. It dragged a misty wave out of the sun.

I knew the story of the Ghosts. That blue thing was the main sun's twin. It was a pulsar; it sprayed gusts of heavy particles across the sky six hundred times a second. Over a billion years that unending particle torching had boiled away the main star's flesh.

The intrasystem drive cut in with a dull roar, a kick in the small of my back.

Then the planet of the Silver Ghosts floated into view.

I heard myself swearing under my breath. It was a world dipped in chrome, reflecting the Universe.

I was flying over a pool of stars. Towards the edge of the pool the stars crowded together, some smeared into twinkling arcs, and the blanched sun sprawled across one pole. As I descended my own image was like a second astronaut, drive blazing, rising from the pool to meet me.

Now I saw what looked like the skeleton of a moon, floating around the limb of the world. I directed monitors toward it. "Wyman. What do you make of that?"

Wyman's voice crackled out of the inseparability link. "That's where they built their ship to the lithium-7 event. They hollowed out their moon and used its mass to boost them on their way."

"Wyman... I hate to tell you this, but they've gone already."

"I know." He sounded smug. "Don't worry about it. I told you, we can beat them. If we need to."

I continued to fall. The pod began speaking to the Ghosts' landing control systems. At last the perfection of the planet congealed into graininess, and I fell amongst silvered clouds. The landscape under the clouds was dark: I passed like a firefly, lighting up cities and oceans.

Under the Ghosts' control I landed in a sweep, bumping. I rested for a moment in the darkness. Then--



I heard music. The ground throbbed with a bass harmonization that made the pod walls sing. It was as if I could hear the heart of the frozen planet.

I lit an omnidirectional lamp.

Mercury droplets glistened on a black velvet landscape. I felt as if I were brooding over the lights of a tiny city. There were highlights on the horizon: I saw a forest of globes and half-globes anchored by cables. Necklaces swooped between the globes, frosted with frozen air...

When their sun decayed the only source of heat available to the Ghost biosphere was the planet's geothermal energy. So the Ghosts turned themselves and their fellow creatures into compact, silvered spheres, each body barely begrudging an erg to the cold outside.

Finally clouds of mirrored life-forms rolled upwards. The treacherous sky was locked out... but every stray photon of the planet's internal heat was trapped.

"I don't get it, Michael," Wyman said. "If they're so short of heat why aren't they all jet-black?"

"Because perfect absorbers of heat are perfect emitters as well," I said. "High school physics, Wyman. While perfect reflectors are also the best heat containers. See?"

"...Yeah. I think so."

"And anyway, who cares about the why of it? Wyman, it's... beautiful."

"I think you've got a visitor."

A five-foot bauble had separated from the forest and now came flying over the sequined field. In its mirrored epidermis I could see my own spectral face. Taped to that hide was a standard translator box. A similar box was fixed to the pod floor; now it crackled to life. "You are Dr. Michael Luce. I understand you represent a Wyman, of Earth. You are welcome here," said the Silver Ghost. "I work with the Sink Ambassador's office."

"The Sink?" I whispered.

"The Heat Sink, Luce. The sky. I am Wyman. Thank you for meeting us. Do you know what I wish to discuss?"

"Of course. Our respective expeditions to the lithium site." The truncated spheroid bobbed, as if amused. "We can make an educated guess about what you seek to achieve here, Mr. Wyman. What we do not know yet is the price you'll ask."

Wyman laughed respectfully.

I felt bewildered. "Sorry to butt in," I said, "but what are you talking about? We're here to discuss a pooling of resources. Aren't we? So that humans and Ghosts end up sharing--"

The Ghost interrupted gently. "Dr. Luce, your employer is hoping that we will offer to buy him out. You see, Wyman's motivation is the exploitation of human technology for personal profit. If he proceeds with your expedition he has the chance of unknown profit at high risk. However, a sell-out now would give him a fat profit at no further risk."

Wyman said nothing.

"But," I said, "a sell-out would give the Ghosts exclusive access to the lithium knowledge. All that creation science you told me about, Wyman... I mean no offense," I said to the Ghost, "but this seems a betrayal of our race."

"I doubt that is a factor in his calculation, Doctor," said the Ghost.

I laughed dryly. "Sounds like they know you too well, Wyman."

"So what's your answer?" Wyman growled.

"I'm afraid you have nothing to sell, Mr. Wyman. Our vessel will arrive at the lithium-7 site in..." A hiss from the translator box. "Fourteen standard days."

"See this ship? It will be there in ten."

The Ghost was swelling and subsiding; highlights moved hypnotically over its flesh. "Powered by your

supersymmetry drive. We are not excited by the possibility that it will work--"

"How can you say that?" I snapped, my pride obscurely wounded. "Have you investigated it?"

"We have no need to, Doctor. Our ship has a drive based on Xeelee principles. Hence it will work."

"Oh, I see. If the Xeelee haven't discovered something, it's not there to be discovered. Right? Well, at least this shows mankind isn't alone in suffering a fracture of the imagination, Wyman."

The Ghost, softly breathing vacuum, said nothing.

"We humans aren't so complacent," snapped Wyman. "The Xeelee aren't omnipotent. That's why we'll have the edge over the likes of you in the end."

"A convincing display of patriotism," said the Ghost smoothly.

"Yeah, that's a bit rich, Wyman."

"You're so damn holy, Luce. Let me tell you, the Ghost's right. This trip is risky. It's stretched me. Unless you come up with the goods I might have trouble paying your fee. Chew on that, holy man."

"Dr. Luce, I urge you not to throw away your life on this venture." The Ghost's calm was terrifying.

There was a moment of silence. Suddenly this world of mirrors seemed a large and strange place, and my own troubled eyes stared out of the Ghost's hide.

"Come on, Luce," said Wyman. "We've finished our business. Let's waste no more time here."

My drive splashed light over the chrome-plated landscape. I kept my eyes on the Ghost until it was lost in a blanket of sparkles.

I soared out of the gravity well of the Ghost world.

"Strap in."

"Disappointed, Wyman?"

"Shut up and do as I say."

The drive cut out smoothly, leaving me weightless. The control screens flickered as they reconfigured. Thumps and bangs rattled the hull; I watched my intrasystem and hyperdrive packs drift away, straps dangling.

The pod was metamorphosing around me.

I locked myself into a webbing of elasticated straps, fumbling at buckles with shaking fingers. There was a taste of copper in my throat.

"Do you understand what's happening?" Wyman demanded. "I'm stripping down the pod. Every surplus ounce will cost me time."

"Just get on with it."

Panels blew out from the black casing fixed to the base of the pod; a monitor showed me the jeweled guts of the Susy drive.

"Now, listen, Luce. You know the conversational inseparability link will cut out as soon as you go into Susy-space. But I'll be -- with you in spirit."

"How cheering."

The pod shuddered once -- twice -- and the stars blurred.

"It's time," Wyman said. "Godspeed, Michael--"

The antique expression surprised me.

Something slammed into the base of the pod; I dangled in my webbing. For as long as I could I kept my eyes fixed on the Ghost world.

I lit up a hemisphere.

Then the planet crumpled like tissue paper, and the stars turned to streaks and disappeared.

Wyman had boasted about his Susy drive. "Hyperspace travel is just a slip sideways into one of the Universe's squashed-up extra dimensions. Whereas with supersymmetry you're getting into the real guts of physics..."

There are two types of particles: fermions, the building blocks of matter, like quarks and electrons, and force

carriers, like photons. Supersymmetry tells us that each building block can be translated into a force carrier, and vice versa.

"The supersymmetric twins, the s-particles, are no doubt inherently fascinating," said Wyman. "But for the businessman the magic comes when you do two supersymmetric transformations -- say, electron to selectron and back again. You end up with an electron, of course -- but an electron in a different place..."

And so Wyman hoped to have me leapfrog through Susy-space to the lithium-7 object. What he wasn't so keen to explain was what it would feel like.

Susy-space is another Universe, laid over our own. It has its own laws. I was transformed into a supersymmetric copy of myself. I was an s-ghost in Susy-space. And it was... different.

Things are blurred in Susy-space. The distinction between me, here, and the stars, out there, wasn't nearly as sharp as it is in four-space.

Can you understand that?

Susy-space is not a place designed for humans. Man is a small, warm creature, accustomed to the skull's dark cave.

Susy-space cut through all that.

I was exposed. I could feel the scale of the journey, as if the arch of the Universe were part of my own being. Distance crushed me. Earth and its cozy Sun were a childhood memory, lost in the grief of curved space.

Eyes streaming, I opaqued the window.

I slept for a while. When I woke, things hadn't got any better.

Trying to ignore the oppressive aura of Susy-space I played with the new monitor configurations, looking for the Susy-drive controls. It took me two hours of growing confusion to work out that there weren't any.

The Susy drive had been discarded after pushing me on my way, like a throwaway rocket in the earliest human flights.

I could see the logic of it. Why carry excess baggage?

There were two problems.

The trip was one way. And Wyman hadn't told me.

I'm not a strong man; I don't pretend to be. It took some time to work through my first reaction.

Then I washed my face and sipped a globe of coffee.

The translator box lit up. "Luce. What's your status?"

I crushed the globe; cooling coffee spurted over my wrist. "Wyman, you bastard. You've hijacked me... And I thought the inseparability link wouldn't work over these distances."

"We have a packet link; but apart from that, it doesn't. This isn't Wyman. I'm a Virtual representation stored in the translator box. I should think you're pleased to hear my voice. You need the illusion of company, you see. It's all quite practical. And this is a historic trip. I wanted some small part of me to be out there with you..."

I breathed hard, trying to control my voice. "Why didn't you tell me this trip was no return?"

"Because you wouldn't have gone," said the Wyman Virtual -- mentally I started calling him "sWyman."

"Of course not. No matter what the fee. -- And what about my fee? Have you paid it over yet?"

sWyman hesitated. "I'd be happy to, Michael. But... do you have an estate? Dependents?"

"You know I don't. Damn you."

"Look, Michael, I'm sorry if you feel tricked. But I had to make sure you'd take the trip. We have to put the interests of the race first, don't we?..."

After that my courage began to fail once more. sWyman had the decency to shut up.

We popped out of Susy-space, sparkling with selectrons and neutralinos.

My time in that metal box had seemed a lot longer than ten days. I don't remember a lot of it. I'd been locked inside my head, looking for a place to hide from the oppression of distance, from the burden of looming death.

Now I breathed deeply; even the canned air of the pod seemed sweet out of Susy-space.

I checked my status. I'd have four days' life support at the lithium-7 site. It would expire -- with me -- just when the Ghosts arrived. Wyman had given me the bare bones.

I de-opaused my window and looked out. I was spinning lazily in an ordinary sky. There was a powdering of stars, a pale band that marked a galactic plane, smudges that were distant galaxies.

Earth was impossibly far away, somewhere over the horizon of the Universe. I shivered. Damn it, this place felt old.

There was something odd about one patch of sky. It looked the size of a dinner plate at arm's length. There were no stars in the patch. And it was growing slowly.

I set up the monitors. "sWyman -- what is it?"

"All I see is a dull infra-red glow... But that's where the lithium object is hiding, so that's the way we're headed."

The patch grew until it hid half the sky.

I started to make out a speckled effect. The speckles spread apart; it was as if we were falling into a swarm of bees. Soon we reached the outskirts of the swarm. A hail of huge objects shot past us and began to hide the stars behind us--

"They're ships."

"What?"

I straightened up from my monitor. "Ships. Millions of ships, sWyman."

I swung the focus around the sky. I picked out a little family of cylinders, tumbling over each other like baby

mice. There was a crumpled sphere not much bigger than the pod; it orbited a treelike structure of branches and sparkling leaves. Beyond that I made out bundles of spheroids and tetrahedra, pencils of rods and wands -- my gaze roved over a speckling of shape and color.

I was at the heart of a hailstorm of ships. They filled the sky, misting into the distance.

But there was no life, no purposeful movement. It was a desolate place; I felt utterly alone.

I looked again at the tree-thing. The delicate ship was miles wide. But there were scorch marks on the leaves, and holes in the foliage bigger than cities.

"sWyman, these are wrecks. All of them."

A motion at the edge of my vision. I tried to track it. A black, birdlike shape that seemed familiar--

"Luce, why the junk yard? What's happened here?"

I thought of a shell of lithium-stained light growing out of this place and blossoming around the curve of the Universe. At its touch flocks of ships would rise like birds from the stars... "sWyman, we're maybe the first to travel here from our Galaxy. But races from further in, closer to this event, have been flooding here from the start. As soon as the lithium-7 light reached them they would come here, to this unique place, hoping as we hope to find new understanding. They've been seeking the lithium treasure for billions of years... and dying here. Let's hope there's still something worth dying for."

Something was growing out of the speckled mist ahead. It was a flattened sphere of blood-colored haze; starlight twinkled through its substance.

It was impossible to guess its scale. And it kept growing.

"sWyman. I think that's another ship. It may not be solid... but I know we're going to hit. Where's my intrasystem drive?"

"Fifteen billion light years away."



There was detail in the crimson fog, sparks that chattered around rectangular paths. Now the huge ship shut off half the sky.

"Lethe." I opaqued the window.

There was a soft resistance, like a fall into a liquid. Red light played through the pod walls as if they were paper. Sparks jerked through right angles in the air.

Then it was over. I tried to steady my breath.

"Why worry, Michael?" sWyman said gently. "We've no power; we're ballistic. If another of those babies runs into us there's not a damn thing we can do about it."

"It's getting clearer up ahead."

We dropped out of the mist of ships and shot into a hollow space the size of the Solar System. On the far side was another wall of processed matter -- more ships, I found. There was a sphere of smashed-up craft clustering around this place like gaudy moths.

And the flame at the heart of it all?

Nothing much. Only a star. But very, very old...

Once it had been a hundred times the mass of our sun. It had squirted lithium-7 light over the roof of the young cosmos. It had a terrific time. But the good days passed quickly. What we saw before us was a dried-up corpse, showing only by its gravity signature.

Just an old star... with something in orbit around it.

I focused my instruments. "That thing's about a foot across," I recorded. "But it masses more than Jupiter..."

The monstrous thing crawled past the surface of its wizened mother, raising a blood-red tide.

"So what? A black hole?"

I shook my head. "The densities are wrong. This is a different ball game, sWyman. That stuff's quagma."

The largest piece of quagma I'd had to work with before had been smaller than a proton. This was my field, brought within miraculous reach. I stammered observations--

Things started to happen.

The quagma thing veered out of orbit and shot towards us. I watched in disbelief. "It's not supposed to do that."

I felt a tingle as it hurtled past, mere yards from my window. It looked like a lump of cooling charcoal. Its gravity field slapped the pod as if it were a spinning top, and centripetal force threw me against the wall.

Clinging to the window frame I caught a glimpse of the quagma object whirling away from the pod and neatly returning to its orbit.

Then a shadow fell across the window.

"That's shot us full of all sorts of funny stuff," shouted sWyman. "Particles you wouldn't believe, radiation at all wavelengths--"

I didn't reply. There was a shape hovering out there, a night-dark bird with wings hundreds of miles across.

"Xeelee," I breathed. "That's what I saw in the ship swarm. The Xeelee are here. That's a nightfighter--"

sWyman roared in frustration.

The Xeelee let us have it. I saw the exterior of the window glow cherry-red; gobbets melted and flew away. The Xeelee dipped his wings, once; and he flew away.

Then the window opaqued.

Something hit my head in the whirling darkness. The noise, the burning smells, sWyman's yelled complaints -- it all faded away.

"...Damn those Xeelee. I should have known they can beat anything we've got. And of course they would police this lithium beacon. It wouldn't do to let us lesser types get our hands on stuff like this; oh no..."

I was drifting in a steamy darkness. There was a smell of smoke. I coughed, searched for a coffee globe. "At least the Xeelee attack stopped that damn rotation." sWyman shut up, as if cut off. "What's our status, sWyman?"

"Nothing that counts is working. Oh, there's enough to let us interpret the quagma encounter... But, Luce, the

inseparability packet link is smashed. We can't talk to home." Cradling the cooling globe I probed at my feelings. There was despair, certainly; but over it all I felt an unbearable shame.

I'd let my life be stolen. And, in the end, it was for nothing.

sWyman hissed quietly.

"How's the life support, by the way?" I asked.

"What life support?"

I let the globe join the cabin's floating debris and felt my way to the opaqued window. It felt brittle, half-melted. It would stay opaqued forever, I realized.

"sWyman. Tell me what happened. When that quagma droplet lunged out of its orbit and sprayed us."

"Yeah. Well, the particles from the quagma burst left tracks like vapor trails in the matter they passed through." I remembered how that invisible shower had prickled. The scars laced everything -- the hull, the equipment, even your body. And the tracks weren't random. There was a pattern to them. There was enough left working in here for me to decipher some of the message..."

I felt my skin crawl. "A message. You're telling me there was information content in the scar patterns?"

"Yes," said sWyman casually. I guess he'd had time to get used to the idea. "But what we can't do is tell anyone about it."

I held my breath. "Do you want to tell me?"

"Yeah..."

*It was less than a second after the Big Bang.*

*Already there was life.*

*They swarmed through a quagma broth, fighting and loving and dying. The oldest of them told legends of the singularity. The young scoffed, but listened in secret awe.*

*But the quagma was cooling. Their life-sustaining fluid was congealing into cold hadrons. Soon, the very superforce which bound their bodies would disintegrate.*

*They were thinking beings. Their scientists told them the end of the world, seconds away, would be followed by an eternal cold. There was nothing they could do about it.*

*They could not bear to be forgotten.*

*So they built... an ark. A melon-sized pod of quagma containing all their understanding. And they set up that unmistakable lithium-7 flare, a sign that someone had been here, at the dawn of time.*

*For trillions of seconds the ark waited. At last cold creatures came to see. And the ark began to tell its story.*

I floated there, thinking about it. The scars lacing the pod -- even my body -- held as much of the understanding of the quagma creatures as they could give us. If I could have returned home engineers could have dissected the pod, doctors could have studied the tracery of tracks in my flesh; and the patterns they found could have been unscrambled.

Perhaps we would never decipher it all. Perhaps much of it would be meaningless to us. I didn't know. It didn't matter. For the existence of the ark was itself the quagma datum, the single key fact:

That they had been here.

And so the ark serves its purpose.

sWyman fell silent.

I drifted away from the buckled walls and began to curl up. There was a band of pain across my chest; the air must be fouling.

How long since I'd dropped out of Susy-space? Had my four days gone?

My vision started to break up. I hoped sWyman wouldn't speak again.

Something scraped the outside of the pod.

"Luce?" sWyman whispered. "What was that?"

The scrape went the length of the pod; then came a more solid clang over the mid-section. "I'd say someone's trying to get hold of us."

"Who, damn it?"

I pressed my ear to a smooth patch of hull. I heard music, a bass harmonization that rumbled through the skin of the pod.

"Of course. The Ghosts. They're right on time."

"No." There was a bray in his voice. "They're too late. Our Susy-drive took the Xeelee by surprise, but if the Ghosts try to get any closer to the quagma you can bet they'll be stopped."

"But--" I stopped to suck oxygen out of the thick air. "The Ghosts don't need to get any closer. The quagma data is stored in the scarred fabric of the pod itself. So if they take the pod they've won..."

Then, incredibly, I felt a glimmer of hope. It was like a thread of blue oxygen.

I tried to think it through. Could I actually live through this?

To Lethe's waters with it. I'd been a passive observer through this whole thing; now, if I was going to die, at least I could choose how. I began stripping off my scorched coverall. "sWyman, listen to me. Is there a way you can destroy the pod?"

He was silent for a moment. "Why should I want to?"

"Just tell me." I was naked. I wadded my clothes behind an equipment box.

"I could destabilize the fusion torus," he said slowly. "Oh. I get it."

"I presume the Ghosts have been monitoring us," I said breathlessly. "So they'll know that my flesh, my clothes, the

fabric of the pod, contain the information they want.

"But if the pod's destroyed... if everything except me -- even my clothes -- has gone... then the Ghosts will have to preserve me. Right? My body will be the only record."

"It's a massive gamble, Luce. You have to rely on the Ghosts knowing enough about human physiology to keep you alive... but not enough to take you apart for the quagma secrets. So they'd have to return you to Earth, to human care--"

"I don't perceive too many alternatives." I grabbed the frame of the pod window. "Will you do it?" More scrapes; a judder sideways.

"It means destroying myself." He sounded scared.

I wanted to scream. "sWyman, your original is waiting for word of us, safe on Earth. If I get through this I'll tell him what you did."

He hesitated for five heartbeats.

Then: "Okay. Keep your mouth open when you jump. Godspeed, Michael--"

Grasping the frame with both hands I swung my feet at the window. The blistered stuff smashed easily and the fragments rushed away. Escaping air sparkled into ice. Sound sucked away and my ears popped with a wincing pain.

Snowflakes of air billowed from my open mouth, and gas tore from my bowels.

I closed my freezing eyes and felt my way around the hull. Then I kicked away as hard as I could.

I waited five seconds, then risked one last look. The Ghosts' moon ship was a silvered landscape, tilted up to my right. A thick hose snaked up to the ripped-open pod. Chrome spheres clustered around the pod like bacteria over a wound.

I saw the flash through closed eyelids.

I tumbled backwards. The pain in my chest passed into a dull acceptance. Those Ghosts would have to move fast.

A cold smoothness closed around me.

There was light behind my eyes. I opened them to an airy room. A window to my left. Blue sky. The smell of flowers. A nurse's concerned face over me.

A human nurse.

Behind him, a Ghost hovered.

I tried to speak. "Hello, Wyman."

A footstep. "How did you know I was here?" His pinched expression made me smile.

"You're looking a lot older, Wyman, you know that?" My voice was a croak. "Of course you're here. You've been waiting for me to die. But here I am, ready to collect my fee.

"I expect the doctors will spend the next year scanning me on all wavelengths, mapping out the quagma scars and working out what they mean. I'll be famous." I laughed; my chest hurt. "But we're going to get the treasure, Wyman. A message from another realm of creation.

"Of course we'll have to share it. Humans and Ghosts... but at least we'll get it.

"And you'll have to share the profits, won't you? And there's my fee as well. You didn't budget for that, did you, Wyman? I'd guess you're about to become a lot poorer--"

He walked out, slamming the door.

"But," I whispered, "we must put the interests of the race first."

There was a bit of blue sky reflected in the Ghost. I stared at it and waited for sleep to return.

*The burst of human inventiveness characterized by the prototype Susy drive was not sustained. As Wyman foresaw, it was simply too easy for human beings to steal what others had already discovered, rather than develop their own.*

*The Susy drive -- unstable, expensive, unproven -- was abandoned.*

*New images formed before my eyes.*

*Suddenly I was looking at my own face.*

*"Jack, every life has a part, in the great cosmic drama we are forced to act out. Watch, now..."*



## Planck Zero

**A.D. 5653**

Recently I've been poring over theoretical physics texts. My friends -- those who can still stand to see me, since the Ghosts rebuilt me -- can't understand it. Okay, they say, you were almost killed by the Ghosts' Planck Zero experiment. It was terrible. But isn't it all over now? Why brood? Why not walk -- or rather, fly -- out into the sunshine, and enjoy what's left of your life?

...But I have to do this. I need the answer to a specific question.

Is there any way out of a black hole?

When I heard of the Ghosts' experiment I made a lot of noise. Eventually their Sink Ambassador agreed to meet me -- but they insisted the venue had to be the exposed surface of the Moon. Earth conditions wouldn't have made a damn bit of difference to a Silver Ghost, of course; it was all part of the Ghosts' endless diplomatic gavotte. As chief administrator of the Ghost liaison project, it was my precise job not to find such matters irritating.

I guess age -- and Eve's death -- were making it harder for me to stomach the pettiness of interspecies diplomacy.

Into Lethe with it.

I rode out on the Sahel Cable, then took a flitter to the Moon. We were to meet outside Copernicus Dome; I suited up and walked out briskly. If the Ambassador had been hoping that my sixty-five years would keep me at home it had another thing coming.

The Silver Ghosts' Ambassador to the Heat Sink floated a yard off the crisp Lunar regolith; the reflection of Earth

was a distorted crescent sliding over its midriff.

We met without aides, as I'd requested, and spoke on a closed channel.

I came straight to the point. "Ambassador, I've asked to meet you because we suspect you are conducting unauthorized experiments on quagma material."

It bobbed up and down, a child's balloon incongruously dispatched to the airless Moon. "Jack, I would like to see evidence to support your allegation."

I was prepared for that. "I'll download the dossier to you. As soon as I'm satisfied you are being just as honest with me."

"Perhaps you are speculating. Perhaps this is a--" Pause. " -- a shot in the dark? You are trying to extract valuable information from me on the threat of evidence which does not exist."

I shook my head. "Ambassador, think it over. Your race and mine have contacts at many levels, right down to the one-man traders. Security measures between our species are as porous as human flesh." A charming Ghost simile.

"Perhaps." Its bobbing evolved into a complex shimmering. "Very well. Jack Raoul, we have grown to know each other, these past decades, and I am aware that you are an honest man... if not always an open one, despite your present posture as an injured party. Therefore I must accept that you have such evidence."

I felt a surge of satisfaction. "Then you are conducting a covert project."

"Covert, perhaps, but not intentionally so from our human partners."

"Oh, really?..." I let it pass. "Then from whom?"

"The Xeelee."

I studied the Ambassador with a sneaking admiration. "I'll be impressed if you manage to keep secrets from the Xeelee. How are you doing it?"

The Ghost began to roll gently. "All in good time, Jack Raoul. We cannot be sure of secure communications, even here."

"This conversation has served its purpose, then. Our staff can proceed with the details--"

"But we would not allow the dissemination of any data. Only an inspection tour, at the highest level, would be acceptable."

"The highest level?"

"Perhaps you would care to visit the site yourself, Jack Raoul."

I laughed. "Perhaps... when I find out what the catch is."

The rolling accelerated. "We know each other too well. Jack, we would have to rebuild you."

There was no inflection in the artificial voice. The image of Earth rippled across Ghost skin.

I shivered.

"Ambassador, just give me one hint. You know I'm an inquisitive man."

"A hint?"

"What are you trying to do, with your quagma?"

The rolling stopped. "You have heard of the Uncertainty Principle..."

"Of course."

"We have violated it."

After my meeting with the Ambassador I returned to our New Bronx apartment, poured myself a malt, slumped on my favorite couch, and called up Eve.

One wall melted. Eve was heartbreakingly real, at least when she didn't move and the image stayed stable.

She looked around quickly, as if establishing where she was, then fixed me with an admonishing stare.

"You're looking good," I said, raising my glass at the wall.

She snorted, but pushed a hand through her grayed hair. "What do you want, Jack? You know this is bad for you."

"I want you to tell me about the Uncertainty Principle."

"Why?"

"I'll explain later."

She frowned. "The walls have plenty of popular science texts--"

"You know I can never understand a word of that stuff unless you explain it to me."

"Lethe, Jack; that's just sentimental--"

"Humor me. It's important."

She sighed and pulled at a stray lock of hair. "All right, damn it. But I'll keep it brief; and when it's over, that's it."

"It's a deal."

Now Eve changed, subtly, so that -- without any obvious reworking of the image -- she seemed younger, more comfortable on the couch. I guessed the wall was accessing an older part of her Notebooks. "To understand Heisenberg's Uncertainty Principle," she began, "you need to get a handle on quantum mechanics."

According to the quantum philosophy, particles like electrons don't exist as points of mass and charge. Instead each electron has a wave function which describes its position, velocity and other properties; it's as if the electron is spread over a small volume of space delimited by the wave function.

"So where does the Uncertainty Principle come in?"

Eve twisted my ring around her finger. "You can reduce the spread of an electron's position wave-volume -- perhaps by inspecting it using very high frequency photons. But the catch is that the wave-volume associated with another variable -- the electron's momentum -- expands enormously. And vice versa.

"So you can never know both the electron's position and momentum; you can never reduce both wave-volumes to

zero."

"Okay. What's the size of these volumes?"

"The scale is given by Planck's constant. Which is a small number; one of the fundamental constants of physics. But in real terms -- suppose you measured an electron's position to within a billionth of an inch. Then the momentum uncertainty would be such that a second later you couldn't be sure where the damn thing was to within a hundred miles."

I nodded. "Then the principle is describing a fundamental fuzziness in reality--"

She waved her hand with exasperation. "Don't talk like a cheap data desk, Jack. There's nothing fuzzy about reality. The wave functions are the fundamental building blocks of the Universe; their governing wave equations are completely deterministic... well, never mind. The Uncertainty Principle is essentially an expression of the scale of those wave functions."

"How does this relate to your work?"

She sighed and sat back in her couch. "It was at the heart of it, Jack."

Eve had spent much of her working life trying to develop the principles of remote translation systems. Teleport beams, to you and me.

She said, "A translation device might work by scanning the position of every particle in an object. That information could be transferred somewhere else and a copy constructed of the original, exact down to the last electron."

"But the Uncertainty Principle tells us that's impossible."

"Correct. But the Principle says nothing about transferring exact data about the wave functions themselves... and that was the approach I was working on. Also, in some way we still don't fully understand, the quantum waves provide a connectivity to space. When two objects are once joined there is a sense in which they are

forever linked, by quantum properties. It may be that unless full quantum functions are copied, remote translation is impossible."

"That which God has joined, let no man put asunder."

She looked at me suspiciously, as if expecting me to burst into tears. "Something like that. Jack, it may also be that consciousness is a quantum phenomenon. Without our defining quantum functions -- without the anchorage they give us to reality, and to those around us -- we are nothing."

I set down my glass, stood and walked to the wall. Hesitantly she got up and walked closer to her side. "And this wave-function mapping was the technical barrier you could never breach."

She shrugged. "Perhaps it's just as well. Because if this was a perfect image of me, Jack, stored in this wall, you'd never leave this damn apartment." She looked up at me, and I imagined her eyes softening. "Would you?"

"What would happen if you violated the Uncertainty Principle?"

The image wavered slightly; I imagined the wall frantically searching its datastores for a response. "You can't. Jack, haven't you understood a word I've said?"

"Just suppose."

She frowned. "If the uncertainty limit were lowered somehow then greater data compression would be possible. Better data storage."

"So sharper wall images. What else?"

"Faster, more compact computing devices." The image crumbled for a sudden, shocking moment into a storm of cubical pixels. "Jack, this is right at the edge of what I left in my Notebooks."

"Bear with me, please... it is important. How would you do it?"

She rubbed the bridge of her nose, as if her head was aching. "Assuming you're talking about the Universe we're living in -- so the fundamental laws are the same -- you'd

have to find a way of reducing Planck's constant, over some region of space. The interface between Planck-differentiated regions would be kind of interesting. But it's impossible, of course." She looked up at me, troubled. "Jack, I don't like this. It makes me feel -- odd."

"I'm sorry." Without thinking I reached for her, through the wall; but my hand passed through her arm with little resistance.

"Jack. Don't." She stepped back, out of my reach. "It only hurts you."

"I have to go away."

"What?"

"I'm to make an inspection of a Ghost experiment. They say I must be physically modified... I might not come back."

"Well, why not," she said. "Lethe, Jack, I've been dead three years. You're getting morbid." Then she raised both hands to her head and said indistinctly, "If Planck's constant were taken to the ultimate, down to zero--"

"What? Eve, tell me."

She looked at me through a hail of pixels, her eyes wide. "Space could shatter--"

She dissolved. The wall became a wall again.

So I was made a Ghost.

My brain and spinal cord were rolled up and moved into a cleaned-out chest cavity. My circulatory system was wrapped into a complex mass around the brain pan. The Ghosts built a new metabolic system, far more efficient than the old and capable of working off direct radiative input. New eyes, capable of working in spectral regions well beyond the human range, were bolted into my skull; and I was given Ghost "muscles" -- a tiny antigravity drive and compact actuator motors.

At last I was dipped in something like hot mercury.

The Sink Ambassador came to see me while I was being reconstructed. Its voice was like a bird hovering in the darkness. "How do you feel?"

I laughed -- or sent appropriate impulses to my translator chips, at least. "How do you think I feel?"

"They tell me your spirits are high..."

"You're reducing Planck's constant. Aren't you? But I don't understand what quagma has to do with it."

The Ghost hesitated.

When its voice came through again it had a richer timbre. "I have established a closed channel. All right, Jack. You are aware that quagma is the state of matter which emerged from the Big Bang. Matter, when raised to sufficiently high temperatures, melts into a magma of quarks -- a quagma. And at such temperatures the fundamental forces of physics unify into a single superforce. Quagma is bound together only by such a superforce. When quagma is allowed to cool and expand the superforce decomposes into the four sub-forces."

"So?"

"By controlling the decomposition, one can select the ratio between those forces."

"Ah." *Eve, I wish you were here to help me with this...*

"And those ratios govern the fundamental constants -- including Planck's constant."

"Correct."

I wanted to rub my face, but my head and hands had been taken away. "So you're building a model Universe, in which Planck's constant is lowered. Lethe, Ambassador. I'm surprised the Xeelee have let you get as far as you have."

"We have concealed well... Jack Raoul, are you still human?"

I would have shrugged. "I don't know."

"You don't sound as if you care."

"Why should you?"



"I have known you for a long time, Jack. Among my people there are analogies for the grief you felt at the loss of your wife."

"Ambassador, do you think this is some complicated way of committing suicide? You invited me to take the damn trip, remember."

"Human or not, you will still have friends."

"You can't imagine how much that comforts me."

They disconnected my new senses during the hyperspace flight. "I apologize," the Sink Ambassador said. "When we reach the quagma project site you will have freedom to inspect."

"But you don't trust me with the location."

"I do not have a free rein, my friend."

I spent the passage floating in a Virtual reality, trying not to think about what lay beyond my skin.

I emerged into a half-Universe.

I was in a Ghost intrasystem cruiser, a rough ovoid constructed of silvered rope. Instrument clusters were knotted to the walls. Perhaps a dozen Ghosts clung to the rope like berries on seaweed.

Above me I saw stars. Below me a floor of crimson mist, a featureless plane, extended to infinity.

A Ghost approached me.

"Ambassador?"

"We have arrived, Jack Raoul."

"Arrived where?" I gestured at the blood-red floor. "What's this?"

The Ambassador rolled, as if amused. "Jack, this is a red giant star. Are you familiar with astrophysics? This star is about as wide as Earth's orbit. We have emerged a million miles above its boundary."

I'm no small-town boy; I'd been off Earth before. But this was different. I felt the soft human thing inside my Ghost shell cringe.

I'd seen nothing yet.

The ship plunged into the interior of the star.

I cried out and grabbed at silvered rope. Glowing banks of mist shot upwards all around us. The Ghost crew floated about their tasks, unconcerned.

"Lethe, Ambassador."

"I could not warn you."

We emerged into a clear layer within the star. Far, far below was a dense ocean of fire, looking like some fantastic sodium-lit cityscape; beneath it something small, hot and yellow glowed brightly. We descended through slices of fire-cloud with startling speed.

The Ambassador said, "You are perhaps aware that this giant is a star in the latter part of its life. Its bulk is a gas whose density is only a thousandth that of Earth's atmosphere, and whose temperature is well below that at the surface of Sol. Easily managed by your new skin. So you see, there is nothing to fear."

Now the ship veered to the right, and we skirted a huge, blackened thunderhead. "A convection fount; complex products from the core," explained the Ghost.

"The core?"

"Like a white dwarf star, about the size and mass of Sol. It is mostly helium by now, but hydrogen fusion is still proceeding in a surface layer." The Ghost rolled complacently. "Jack, your visit -- this project -- is inspired by quantum mechanics. Do you understand the Pauli Exclusion Principle? -- that no two quantum objects can share the same state? You may be amused to know that it is electron degeneracy pressure -- a form of the Pauli Principle -- which keeps that core from collapsing on itself."

"You're prepared to live inside a star, just to evade detection by the Xeelee?"

"We anticipate long-term benefits."

We dropped into another clear stratus. The core was a ball about as hot and bright as the Sun from Earth; it rolled

beneath us. Starstuff drifted above us like smog.

The Ghosts had built a city here.

Once this must have been a moon. It was a hollowed-out ball of rock, a thousand miles wide. Ghost ships swept over the pocked landscape.

At the poles two vast cylindrical structures gleamed. These were intrasystem drives, the Ambassador explained, there to maintain the moon's orbit about the core.

Our ship approached the city-world's surface -- there was negligible gravity, so that it was like hovering before some vast, slotted wall -- and, at length, slid into an aperture.

I turned to the Ambassador. "I won't pretend I'm not impressed."

"Naturally, after this demonstration, I will provide you with any backup data you require for your report."

"Demonstration? Of what?"

A hint of pride shone through the thin, sexless tones of the translator chips. "We have timed your arrival to coincide with the initiation of a new phase of our project."

"I'm honored."

We hurtled along dimly-lit passages. Other craft dipped and soared all around us. Blocks of light tumbled from cross-corridors, reminding me irresistibly of pixels. I recalled Eve's strange, ambiguous warning, and wondered bleakly if I really wanted to be present at the dawn of a "new phase."

With a soundless rush we emerged into a spherical cavity miles wide. Beams of crimson starlight crossed the hollow, bathing its walls with a blood-red glow. At the heart of the chamber was a sphere. A couple of miles across, the sphere gleamed golden and was semi-transparent, like a half-silvered mirror. Platforms bearing Ghost workers hovered over its surface.

Some vast machine moved softly, within the confines of the mirrored sphere.

"Mr. Raoul, welcome to our experiment," the Sink Ambassador said.

"What is that sphere?"

"Nothing material. The sphere is the boundary between our Universe... and another domain, which we have constructed by letting quagma droplets inflate under controlled conditions. Within this domain the ratio you know as Planck's constant is reduced, to about ten percent of its value elsewhere. Other physical constants are identical."

"Why the half-silvered effect?"

"The energy carried by a photon is proportional to the Planck number. When a photon enters the Planck domain the energy it may carry is reduced. Do you understand? It therefore sheds energy at the boundary, in the form of a second photon, emitted back into normal space."

I asked if we were to enter the Planck space.

"I fear not," the Ambassador said. "Our fundamental structure is based on Planck's constant: the spacing of electrons around the nucleus of an atom, for example. If you were to enter the domain, you would be -- adjusted. The device in there -- an artificial mind -- has been constructed to withstand such Planck changes. The device controls the regeneration of the domain from quagma; we are also using it to conduct computational experiments."

The machine in its golden sac turned, brooding, like some vast animal.

"Ambassador, what is your purpose?"

The Ghosts, the Ambassador said, had two objectives. The first was to use the Planck boundary conditions to build a perfect reflective surface, an age-old goal of the energy-hoarding Ghosts.

The second objective was more interesting.

"The capacity of any computing machine is limited by the Uncertainty Principle," the Ambassador said. "The exploration of, say, high-value prime numbers has always

been constrained by the fact that energy changes within a device must remain above the uncertainty level.

"With the reduction in Planck's constant we can go further. Much further. For example, we have already managed to find a disproof of an ancient human hypothesis known as Goldbach's conjecture."

Goldbach, it seems, speculated that any even number can be expressed as the sum of two primes. Twelve equals five plus seven; forty equals seventeen plus twenty-three. Centuries of endeavor had neither proved nor disproved the hypothesis.

The Planck machine had found a counterexample, a number in the region of ten raised to the power eighty.

"I guess I'm impressed," I said.

The Ghost rolled gently. "My friend, age-old problems melt before our Planck machine; already several NP-type problems have--"

I told the Ambassador I believed it, and to dump down the details later.

The science platforms were pulling away now, leaving the gold-silver sphere exposed and alone.

The Sink Ambassador continued its lecture. "But we want to go further. We see this Planck-adjustment technique as a means of probing -- not just the very large -- but the infinite. Our device will verify some of the most important theorems of our, and your, mathematics, simply by a direct inspection of cases, all the way to infinity."

I stared at the bobbing Ghost. "I think you're losing me. Won't an infinite number of cases still take an infinite amount of time? -- and energy?"

"Not if the time and energy is allocated in decreasing amounts, so that the total converges to some finite value. And -- if the Uncertainty Principle is removed completely -- there is no limit to the smallness of energy allocations."

"Right. So you're going to take Planck's constant all the way to zero."

"That's right. And, Jack, mathematical conjectures are just the start. A training exercise. The artificial mind is heuristic -- it is flexible; it can learn. With its infinite capacity at our disposal we anticipate the dawn of a new era of--"

There was a spark, dazzling bright, at the heart of the silvered Planck sac. The mind-device thrashed like some grotesque fetus.

I knotted my fingers in a length of silvered rope. "Ambassador, 'space could shatter.' "

"What?"

"What does that mean to you?"

"...Nothing. Jack, are you--"

The flame filled the sac, overwhelming the machine. For an instant the sac glowed brighter than the star core.

Then the sac turned silver. It looked like some huge Ghost. Images of the crowding science platforms, of the slotted walls of the city-world cavity, shivered over its flanks.

"Ambassador, what's happening?"

"...I'm not certain."

"Have you achieved Planck Zero?"

"Yes. But the device should be signaling to us--"

The walls of the sac contracted by a few hundred feet, trembling; it was as if the sac were a living creature, breathing in.

My ship lurched away from the sac and towards the walls of the chamber. One crewman was left tumbling in space, like a drop of mercury in freefall. I clung grimly to my rope.

The walls were still miles away.

The sac's surface billowed out and overwhelmed us.

I was utterly alone.

Lonely.

Darkness.

...Dark because photons could carry no energy, here at Planck Zero; nothing to excite my optic sensors...

Cold. How could I be cold? I rubbed my hands together. I could feel my fingers break up like ancient, crumbled paper.

Electron orbits in an atom are proportional to Planck's constant. At Planck Zero the orbits must collapse... right? So, no more chemistry. How long before the crumbling process reached my brain pan?

How would it feel?

And quantum wave functions, linking me to the rest of the Universe, had all turned to dust at Planck Zero.

I could feel it. I was alone in this shattered space.

What about the ship? Was it still heading for the wall?... Something else, in here with me. The Ghosts? No; something larger, more powerful.

Infinite.

The mind-device was without limit. It was stranded in this discontinuous space, and it was enraged.

Enraged by a pain I recognized.

Now I made out other minds. Ghosts. They were like tiny stars, shining out, falling away from each other.

The Planck mind lashed out. Ghosts were overwhelmed, insects in fire.

...The ship burst out of the sac; quantum functions rushed over me (for a precious moment visible, like prismatic waves lapping around me) and I was bound into the Universe once more.

The ship hurtled through a city-world passage, trailing ragged fragments. Ghosts lay dying all around me, their proud bodies deflated.

I looked back down the passage. A silver half-dome peered after us like some vast eye.

"...Sink Ambassador?"

"I'm still here, Jack."

We emerged from the city-world. Ghost paramedics floated onto our ship and tended the wounded.

The city-world was changing.

A light, clear and white, shone out of the hundreds of portals, illuminating the murky giant star material. The massive drive assemblies at the poles had been damaged; I saw sparks fizzing across the surface of the nearer. A flotilla of heavy Ghost ships approached the drive units.

"Ambassador, what are they doing?"

"We must endeavor to repair the drive units, or the moon will fall into the core... Jack, the growth of the Planck sac in that cavity was not controlled. We are afraid."

"I bet you are."

"We are going to try to move the moon out of the giant star."

"And then what?"

"We must find some way to restrain the sac."

I stared down at the core of the giant. "Ambassador, it will overwhelm you. What are the limits to its growth?"

"There are no limits. Perhaps the Xeelee will intervene."

"The Xeelee aren't gods." I thought fast. "Sink Ambassador, listen to me. Do you have any influence over operations here?"

"Why?"

"Stop the efforts to repair the drives."

"...I do not have the authority."

"Then find someone who does. As acting human ambassador here, I formally request this. Sink Ambassador, have you recorded that?"

"Yes, Jack. Why do you want this?"

"Because I'm frightened, too. But I think there is a way out."

The Ghosts cut the drive assemblies loose from the city-world. Within an hour the Planck sac had overwhelmed the battered moon; it hung in the giant star glow, perfectly



silver. They got us out of there. I could see reflections in the sac's surface, chains of ropy Ghost ships heading for safety. It took about a day for the Planck sac to impact the star core. By that time it was ten thousand miles wide and still growing. Huge ripples crossed its monstrous surface. It slid inside the star core, fusing hydrogen closing smoothly over the shining ovoid, vacuoles flaring.

An hour later the core started to implode.

Disembodied, the Sink Ambassador and I floated over Virtual images of the collapsing core. I said, "I wish Eve could see this."

"Yes."

By now, of course, the Ghosts had figured it out for themselves; but I couldn't resist rubbing it in. "It was your chance comment about electron degeneracy pressure that gave me the key. Suppose Planck were reduced to zero in the star core. The higher quantum states would collapse -- spin values, for instance, would fall from Planck multiples to zero."

The Pauli Exclusion Principle could not work, and electron degeneracy pressure would fail. The star core must implode... all the way, past the neutron star compaction limit, on to become a black hole.

"Actually," the Ambassador said smoothly, "there are technicalities you didn't consider. For example, no electron can have zero spin value. Nor can any fermion. Presumably the core fermions are collapsing to bosons, like photons... The physics must be interesting in there."

"Whatever. It worked, didn't it?"

"Yes. We have contained the Planck Zero sac expansion. Within an event horizon, for all time."

"And we've locked away your Planck Zero AI."

The Ghost thought that over. "That is important to you?"

"What did you sense, inside the sac?"

"Infinite power... and anger."

"There was more, Ambassador. In discontinuous space, without the anchorage of quantum wave functions, it was utterly alone. And lonely. And it was furious. Do you see?"

Quantum loneliness.

I had recognized a fellow sufferer. In my loneliness I can only hurt myself, but the mind-device had an infinite capacity for destruction. Still, it was trapped now...

Then I began to wonder, and I haven't been able to stop. Is there any way out of a black hole?

*The images conjured up by Eve had been like reflections in the glimmering walls of the Planck sac.*

*I brooded, for a while unable to speak.*

*Eve asked, "Are you all right?"*

*"I don't know."*

*I'd relived it all again. The rebuilding. The horror of that quantum loneliness.*

*"Nobody should have to go through that twice," I said angrily.*

*"I know, Jack. And I'm sorry. But it's important that--"*

*"-- I understand. I know. What next, Eve?"*

*"Next," she said, "we'll look ahead..."*

*"Ahead? Into the future? How is that possible?"*

*"Watch," she said. "Just watch."*

*...Five thousand years in the future, and ten thousand years after its first eruption from Earth, humanity's colonization wavefront spread at lightspeed through the Galaxy.*

*Its experiences, at the hands of the Qax and others, had changed humanity.*

*Never again would humanity be made to serve at the behest of some alien power.*

*As humans grew in power, the conquest of other species became an industry. A new era began.*

# **PART 4**

## **ERA: Assimilation**

# The Godel Sunflowers

**A.D. 10515**

It was one of the oldest stars in the Galaxy, a sphere of primordial matter hovering in the halo like a failed beacon. About five hundred of its contemporaries still sprinkled photons over the young-matter soup of the swirling main disc, defiant against the erosion of aeons.

But this star had failed, long since. Now it was choked with iron; carbon dusted its cooling surface.

The artifact humans called the Snowflake surrounded this dwarf star, a vast setting for an ancient, faded jewel.

Since the construction of the Snowflake, fourteen billion years had shivered across the swirling face of the Galaxy.

Now, at last, from out of the main disc, a ship was climbing up to the Snowflake.

Throughout his voyage from Earth aboard the Spline warship, Kapur remained alone. Endlessly he studied Virtuals on his destination, trying to comprehend the task that confronted him.

Kapur would be given five days to complete his task.

He was a policeman, seconded to this assignment. In the fleshy warmth of the Spline's interior, the enormity of the crime he must prevent kept Kapur awake for long hours.

The Spline ship was a mile-wide ball of hardened flesh. Buried deep in pockmarks, sensors which had once been eyes turned slowly in response to the electronic prompting of humans.

The Spline sailed to within a hundred million miles of the Snowflake, slowed, stopped. For days it hovered. A

swarm of passive, powerless probes were sprinkled cautiously over the Snowflake.

The disc of the Galaxy was smoke shot through with starlight, a carpet beneath this slow tableau.

At last the flesh of the Spline puckered, split, parted. A childcraft, a cylinder of silver, wriggled out of the revealed orifice. The child spread shining sails and shook them into a parasol shape; the sails seemed to glisten, as if damp from the womb.

Ruby-red laser light seared from the Spline, lanced into the sails. Slowly, slowly, the fine material billowed in response and filled out. Like thistledown, goaded by the laser-breath of the Spline, the child-yacht descended towards the Snowflake.

The interior of the yacht was a box twenty feet long and six wide. It was too small for two men and the equipment which kept them alive.

Kapur sat before the viewport which formed much of the nose of the yacht. Through the port he could see the dwindling fist of flesh that was the Spline freighter, the perpetually startling sight of the Galaxy in plain view. But even though the yacht was now mere hours away from its rendezvous, of the Snowflake he still saw nothing; not even a rusty smudge, he thought sourly.

Mace, the yacht's other occupant, sat close to Kapur. He peered out with interest, his Eyes gleaming like an insect's. Mace was a Navy man. Kapur, dark, slim, uncomfortable in his borrowed Navy uniform, shrank from Mace's confident bulk.

Mace swiveled his turret of a head towards Kapur. "Well? What do you think of the 'Flake?'"

Kapur shrugged, in the small space he occupied. "What do you expect me to think?"

Mace peered at Kapur, then frowned. "Maybe if you Opened your Eyes you could form an opinion."

Kapur, reluctant, complied.

His Eyes' response spectrum broadened away from the narrow human band; his retinae stung under a sleet of photons of all wavelengths.

The Galaxy dazzled, its core shrieking X-rays. The Snowflake emerged from the darkness like frost crystallizing on a windowpane.

"Let's get to work," Mace said. "We'll review the gross features first. OK?"

Kapur, his Eyes full of the infinite recesses of the Snowflake, did not reply.

"The 'Flake is a regular tetrahedron," Mace said. "It's built around the remains of a black dwarf; the ancient star is at the tetrahedron's centroid. The Snowflake measures over ten million miles along its edges. We don't know how it maintains its structure in the gravity well of the star." Mace's voice was bright, clear, interested, and entirely lacking in awe. "The artifact has the mass of the Earth, approximately. But the Earth is eight thousand miles wide. This thing has been puffed out like candy-floss; it's filled with struts, threads and whiskers of iron, like delicate scaffolding. The structure's not a bad approximation to a space-filling curve. Strictly speaking it has a fractional dimension, somewhere between two and three... And it has a fractal architecture. Do you know what that means?"

"I don't have a math background," Kapur said.

Mace let his silence comment on that for a long second. "You're going to do well with the Godel theorem, then," he said lightly.

"What?"

"Never mind. When we inspect the 'Flake closely we'll find the tetrahedron motif, repeated again and again, on all scales. That's why we call it the Snowflake," Mace said. "Not because of its shape, but because a snowflake is fractal too. Recursive structures at all scales. And it's been there a long time."

"How do you know that?"

Mace, his Eyes fixed on the 'Flake, absently rubbed at his nostrils with his palm. "Because it's so damn cold. In the aeons since its sun died, it's cooled to close to the background temperature of the Universe -- three degrees above absolute zero... although," he mused, "when the thing was built the sky still shone at about eighteen K.

"Do you understand what these numbers mean, Kapur? I know you've hardly been off Earth before this assignment." Mace wasn't bothering to conceal his relaxed, malice-free contempt. In fact this was Kapur's second such mission. The first had been a requisition to the failed Assimilation of the Khorte Colony.

He said, "Why iron?"

"Because iron is the most stable element. The Snowmen -- the builders -- wanted this to last a long time, Kapur."

Kapur nodded. "Then was this a planet, once, before being spun out like a... fairy tale castle?"

"Maybe. Maybe not. When this was built, only a billion years after the Bang, there were scarcely any heavy elements to form planets. The Galaxy itself would have been no more than a disc of smoke, illuminated here and there by hot-spot protostars." The gun-metal Eyes rotated to Kapur. "Kapur, you also need to understand that it's not just the physical structure that's important here. There are many levels beyond the material; even now that thing is an iron-wisp web of data, a cacophony of bits endlessly dancing against the depredations of entropy."

Kapur smiled. "You use words well, Mace," he said.

Mace seemed uninterested. He went on, "The Snowmen loaded everything they knew into this artifact. Eventually, they... went away." He grinned at Kapur. "Maybe. Or maybe they're still here."

Kapur shivered; he grasped his own bony elbows. "And why, my friend? What do you think? Why did they build this marvelous sculpture of iron and data, slowly cooling?"

Mace still grinned. "It's your job to find out, isn't it?"

Kapur stared into the cold, waiting heart of the Snowflake.

He was not expected to succeed here.

Kapur had failed before.

He had watched the Khorte Colony, an ancient, hivelike accretion of crystalline carbon -- diamond -- fold in on itself, burn, die; perhaps one percent of the Colony's stored knowledge had been saved amid the devastating beams.

Kapur's mission was Assimilation. Humans would not let the Xeelee take anything they could not Assimilate.

Kapur wondered if this bright young Navy man had ever heard of the Khorte Colony.

The yacht tacked into the laser breeze, slowed, halted before one tetrahedral plane. Two men pushed through an air-curtain into space, bulbous and clumsy in cold-suits.

The faintest spurt of low-velocity helium pushed at Kapur's back, propeling him towards the Snowflake. The fat, padded suit was snug and warm around him, like a blanket; he felt oddly safe, remote from the immensities around him. At the center of his visor Mace sailed ahead, arms and legs protruding comically from the bulk of his cold-suit.

They stopped a few thousand miles from the iron plane. The face swept to infinity all around Kapur like a vast geometrical diagram; the horizon was razor-sharp against the intergalactic darkness, the three vertices too distant to perceive as corners. His Eyes, set to human wavelengths, made out some detail in the 'Flake; it was like a gigantic engraving, glowing dully in the smoky light of the Galaxy.

Kapur felt small and helpless. He had four days left.

Mace's commentary came to him along a laser path, helmet to helmet. "All right," Mace said. "Here we are in our patent cold-suits; inside, as snug as bugs; outside,



radiating heat at barely a fraction more than the background three K."

As Kapur stared the Snowflake seemed to open out like a flower; he saw layer on layer of recursive detail, sketches of nested tetrahedra dwindling into the soft brown heart of the artifact. "It's wonderful, Mace."

"Yeah. And as delicate as wishes. Hey, Kapur. Give me your Eyes. I'll show you the data."

Kapur hesitated, gathering his resolve.

He hated using the implants. Each time he Opened his Eyes he felt a little more of his humanity leach away.

Now he breathed deeply. The air inside the cold-suit was warm and scented, oddly, of cut grass. With an odd, semi-hypnotic relinquishing of will, he deferred to Mace.

His Eyes Opened wide.

The Snowflake changed, kaleidoscopically.

"You're seeing a construct from our passive probes," Mace whispered. "False-color graphics of the data streams."

Terabits of ancient wisdom hissed on whiskers of iron, sparking like neurons in some splayed-out brain. It was beautiful, Kapur thought; beautiful and monstrous, like the mind of the antique gods of mankind.

His soul recoiled. He sought refuge in detail, the comparatively mundane.

Kapur knew that the mission profile had been designed with caution in mind. The Spline ship had parked over an AU away; he and Mace had approached in a yacht riding a tight laser beam, eschewing chemical flame. "Mace, what would happen if we let stray heat get at the 'Flake? Would we disrupt the structure?"

"You mean the physical structure? Maybe, but that's not the point, Kapur. It's the data that's the treasure here."

"And would a little heat be so harmful?"

"It's to do with thermodynamics. There's a lower bound on how much energy it takes to store a bit. The limit is set

by the three K background temperature of the Universe."

"So the lower that global temperature is, the less energy a bit would take."

"Right. And so if we raised the 'Flake's temperature, even locally, we would risk wiping out terabits. Also, it follows from the thermodynamic limit that there's an upper bound on how much data you can store with a given amount of energy -- or, equivalently, mass. The upper limit for the Snowflake's mass is around ten to power sixty-four bits. Kapur, we estimate that the 'Flake actually holds around ten to power sixty."

Kapur stared into the flowerlike heart of the Snowflake. "I should be impressed?"

"Damn right," Mace growled, "For a start, the whole of human civilization would be characterized by only ten to power twenty bits. Even after hundreds of Assimilations. And, just in technological terms, to get within four orders of magnitude of the theoretical limit... it's almost unimaginable."

"Now. Look." Mace, silhouetted like a cartoon grotesque, pointed at a knot of color and activity. Kapur perceived something like a sunflower, a fist of spirals and tessellations surrounded by "petals," great sheets of information which faded into the background chatter. Pellets of data streaked into and out of the core -- a little like insects, Kapur thought at first; but then he saw how the pellets embedded themselves in the sunflower, endlessly enriching and renewing it.

"What is it?"

"It seems to be the dominant data configuration," Mace called. "The analogue of the tetrahedral motif on the physical level. It represents a theorem. See, the heart of the structure is the core statement, the petals corollaries, endlessly thrown off and lost..."

"What theorem?"

"Godel's Incompleteness. We think. We're guessing, extrapolating on hints of structure we've picked up elsewhere... But it's not really a theorem, here. It's merely a statement of the result. Like an axiom; a given."

"I don't understand."

Mace laughed, briefly and scornfully. Wriggling before the landscape of information he pointed again. Amid a meadow of data structures, Kapur picked out another sunflower, the characteristic Godel shape. Mace jabbed both arms against the vast data diorama, again and again. "There, and there! What do you see, Kapur?"

Godel, Kapur saw, repeated over and over; there was a fractal spiral of Godel sunflowers here, embedded in this chill web of data.

"There's more, of course," Mace said. "We've recognized a lot of physical understanding in here, particularly representations of cosmic events. See that starburst?" A firework of red and yellow, endlessly dynamic, scattered a hundredfold through the 'Flake. "That's Mach's principle: that the inertia of an object is induced by the net gravitational attraction of the rest of the Universe--"

"Tell me about Godel," Kapur said patiently.

On the low-quality laser link, Mace's voice was like a buzzing insect. "Godel was a genius. An Austrian; a Mozart of his subject. In the middle of the twentieth century he produced a theorem on undecidability.

"Godel studied mathematics in the abstract. Think about that, policeman: not just the mathematics you studied at high school; not the maths I studied in the Navy college -- but any sort of mathematics which it is possible to construct."

"You have my attention," Kapur said dryly. "Go on."

"Godel showed that within any mathematical scheme you can write down statements which it would be impossible to prove or disprove. They are undecidable, you see. And so mathematics can never be made complete. You

could never deduce everything from a finite set of axioms; there would always be new statements to make... new facts to record, if you like."

Kapur shook his head. "I cannot imagine how it is possible even to begin to frame such a theorem, let alone to prove it."

"It isn't that difficult," Mace said lightly. "It's rather like the standard proof that the real numbers are uncountable; you make a list of all possible statements within your general mathematical scheme -- and from that list generate another statement which isn't in the list--"

"Never mind." Kapur let the terrifying implications sink in. How could there be a hole in mathematics -- in the most fundamentally abstract of human inventions? He felt as if the floor had fallen away from his Universe.

What kind of people had these Snowmen become, to hold such an awesome, nihilistic theorem at the heart of their philosophy?

Kapur closed his Eyes again -- turned them off, in fact; the orchard of data frost-flowers melted to cold, inert iron.

Kapur and Mace made three more trips to the iron epidermis of the Snowflake. Mace pointed out more forests of rustling data, tentatively mapped by humans. There were tigers in those forests, though, Kapur came to realize; great beasts of wisdom and understanding whose nature humans could not even guess at.

Kapur spent several of his precious hours hanging immobile, his cold-suit barely warmer than the ancient, surrounding echo of the Big Bang. He felt old, inadequate. Assimilation -- bloodless Assimilation -- depended on psychology, on the determination of *goals*. The goal of humanity was to rise up, to grow, and ultimately to confront the Xeelee. If Kapur could determine the goals of the Snowmen, then those objectives could be subverted to

serve human purposes. If not, then the 'Flake, the 'Men, had no value.

But how could Kapur, inexperienced as he was, touch the dreams of the ancient individuals frozen into this data sculpture?

He consoled himself with the thought that failure would be no disgrace, that he could return to his home, his job, without shame.

Kapur did not discuss his feelings openly with Mace; but, as his time wore away in the musty cage of the yacht, he sensed Mace's swelling mood of triumph. The Navy man was intelligent and endlessly fascinated by his surroundings, Kapur came to see; but he clearly felt that Assimilation was a fool's errand, a sop thrown to liberal instincts before the Navy was unleashed.

He was probably right, Kapur thought.

It was Mace's faint gloating, as much as a sense of outrage at the damage the Spline gravity wave planet-breakers would do to the Snowflake, which determined him to keep trying to the end of his time. He could endure failure, he decided; but not failure in front of Mace.

He had a new idea.

"Tell me this," he said to Mace. "How much data characterizes a human being?"

Mace opened his mouth, closed it again.

Kapur pressed politely, "If my thoughts were somehow transcribed, day and night for my entire life -- how many bits to capture that?"

Mace smiled and closed his Eyes. "All right, policeman; let's play games. You produce, let's say, a hundred thousand discrete thoughts per day. Each concept is -- what, a hundred bits?"

"We'll give you fifty years of active adulthood, between infancy and the onset of age. That gives, ah, two times ten to power eleven bits in all." Mace pursed his lips, opened his Eyes and studied Kapur briefly. "Interesting. So there's

the equivalent of something like ten to power forty-nine human individuals in the 'Flake--"

Kapur nodded. "Isolate one of them, with your sensors. Can you do that? Pick out an island of bits. I don't want to know what happens within it; arrange it so I only perceive the inputs and outputs."

Mace rubbed his chin. "You want to talk to a Snowman?"

"Don't mock me," Kapur said patiently.

"What will you talk about?"

Kapur, feeling his way, thought quickly. "Godel's theorem."

Mace leaned forward, ready to scorn -- then hesitated. "Well, why not?" he said at last. "You could give it a human proof of the theorem. That might be kind of interesting."

Kapur waited, but Mace's laughter did not come. "You have to help me understand you, Mace. Are you serious?"

"Sure... I'll code up the proof in a form compatible with their storage templates; I'll dump it into your Eyes and you can download it into the sensors when we go over there again."

"No." Kapur held up a hand. "I want you to let me go alone."

Mace's Eyes glinted, steel globes embedded in the flesh of his lively, amused face. "Why?"

Kapur held his gaze. "Because you're waiting for me to fail. I don't need that; I don't consider this any kind of game, or contest between us. I don't want you around me."

Mace laughed, uncertainly. Then, as he perceived Kapur's seriousness, a look of bafflement and hurt spread across his broad face. This, Kapur realized, could be the first time any human being had rejected Mace in any way. He searched Mace's face for remorse, for shame; but he found only wounded pride.

"Do what you like," said Mace at last. "I'll code up the proof." There were two days left.

Kapur saw the Snowman as a dully-glowing globe of purple, miles wide, embedded beneath the planar skin of the 'Flake. Mach starbursts, Godel sunflowers and other characteristic formations littered the globe, as still as flowers under glass. 'Flake data streams chattered softly into the Snowman, and human sensor probes ringed the 'Man like patient puppies, blocks of metal silhouetted against lurid data.

Kapur, swaddled in his cold-suit, cowered. Here, confronting the reality of the 'Flake, his isolation scheme seemed vacuous. He had no idea, of course, if the arbitrary assemblage of data before him represented an individual -- or, indeed, if consciousness itself persisted at all in the 'Flake.

He was almost certain that it did not.

But he had to try, he reminded himself.

Enough. He focused his gaze on the nearest of the probes; tight laser light slid from his Eyes and into the probe's cold hide.

When the link was secure he downloaded the human proof of Godel to the probe.

The proof was a string of orange beads on a wire of light; the beads splashed against the target probe and rattled into the Snowman. Finally they settled into a cubical configuration: neat and precise, although dwarfed by the richness and profusion of other forms within the 'Man.

'Flake data slugs lanced through the human proof, copying, integrating -- but changing nothing.

Kapur opened a line to Mace, in the yacht. "I don't understand," he said. "Why don't they evaluate, interpret our proof?"

"Are you surprised? Maybe the Snowmen aren't interested in interpretation and evaluation."

"What do you mean?"

"Godel's Incompleteness, remember? No matter how much you derive from a body of data, there will always be

statements you could not have deduced. Always something else to store."

"...Ah. And Godel is at the heart of their ancient, world-weary, philosophy."

Mace laughed briefly. "I think you're working it out, policeman. Knowing the limitations of deduction, the Snowmen decided that to record events -- and only to record -- was the highest calling of life. And that's all they want to do. They took apart their world, rebuilt it as a monstrous storage system... used all the material at their disposal to freeze as much data as they could. They won't do anything with our proof; for fourteen billion years they have merely watched time unravel--"

"There's your streak of poetry again, Mace."

"Your Assimilation must fail," Mace said bluntly.

Kapur sighed. "Why?"

"Think about it. The Snowmen have no motivation we can connect with. Our actions will mean nothing to them -- we, almost by definition within their Godelian philosophy, dance meaninglessly before them. Even their own destruction would be no more than an event, a final act to be stored and noted."

"That can't be all, Mace. There must be more. Every species wants to grow, to develop." Kapur reflected. "Even if all they wanted was a greater data storage capacity--"

"Come in, Kapur. It's over. I'll call in the Spline."

"No." Kapur closed his eyes, tried to keep the trembling out of his voice. "I still have time."

With slow insolence, Mace said, "It's your mission, policeman."

Without returning to the yacht Kapur had Mace download more human datasets and propositions; and he learned quickly how to input new material -- his own reflections and feelings -- into his Eye stores.

That took most of a day.



Kapur slept briefly, nestled within the meadow scents of his cold-suit.

When he turned to the 'Flake once more, he had six hours left.

The Snowman had not changed. The human proof of Godel remained lodged within its abstraction of a belly, a cold, primitive lump.

Kapur began to download data to the probes: more and more, as rapidly as he could. Mathematics first. He found data on an ancient, failed, experiment, a life form based on the Incompleteness theorem, a bizarre disaster which had resulted in the destruction of a moon, a loss of human life...

Then, on a whim, music -- he watched as ancient compositions frosted into veils of blue ice within the 'Man.

Human history. He told the 'Man of the Xeelee, humanity's vast, implacable foe; and of how mankind was seeking to mobilize the resources of a Galaxy in its war.

He told the 'Man what the humans on board the Spline ship planned to do to the Snowflake.

He told of his own fears, doubts -- his awe, here before the Snowflake, with the Galaxy a cloud beneath him; of his almost superstitious response to Godel; of his fear of failure, and his petty relationship with Mace.

The 'Man was like a mirror, one part of his mind told him, or like a Virtual psychoanalysis program. There was no one there to respond, he knew now, but he told it all anyway.

He told the 'Man of his own, tenuous, qualifications for this Assimilation mission. That he was a policeman; that he specialized in the resolution of the cruel, the vicious, the most bizarre crimes. His job was to work through the sites of crimes, trying to see the smashed property, the bones and scattered flesh, through the eyes of the perpetrator.

Kapur was qualified enough to seek the motivation of the Snowmen, after twenty-five years striving to unravel the minds of aliens within his own species.

All of this shivered into the heart of the Snowman, without comment or reaction, without praise or disgust.

Kapur, his time spent, grew ashamed. He fell silent, arms akimbo, before the maw of the Snowflake.

The 'Man watched steadily.

And, at last, Kapur understood.

Something like a ripple passed under Kapur; it was as if space were a lake on which his encased body floated, passive.

"Kapur." Mace's voice was strained. "The Spline."

Kapur felt enormously tired. "What about it?"

"...It's gone."

Time had run out. The Spline had opened its laser-cannon orifices.

...The ship had been torn aside, dragged from its site like an eyeball from a socket, thrown a million miles across space; it had been left spinning, bruised and torn.

Kapur returned to the yacht.

"Were there injuries?"

Mace's face was wide, blank, angry. "What do you think? But the automatics are functioning; the ship's returning to pick us up. What did you do to the damn 'Flake, Kapur?"

"It was not I who tried to open fire on it," Kapur said softly. "What happened?"

"Gravity waves," Mace said. "Like a tractor beam." Suddenly fear broke to the surface of Mace's hard features; his Eyes seemed even more incongruous, metal islands in a sea of human emotion. He pointed through the viewport, picking out a palm-sized patch of darkness. "From the direction of the Virgo supercluster; although that's probably coincidence..."

"I caught an echo of the beam."

"Kapur, I think I know how they did it."

"The Snowmen?"

"Mach's principle. I think they can manipulate Mach's principle."

Kapur shook his head.

With a kind of irritated patience, Mace said, "The Spline is embedded in a Universe of matter. That matter tugs at the Spline with gravity fields -- but the fields surround the ship uniformly; they are equal in all directions, isotropic and timeless."

Kapur frowned. "And you think the Snowmen have a way of making the field -- unequal?"

Mace laughed uneasily. "I guess you learn a lot in fourteen billion years."

Kapur turned the concept over in his mind. The Mach beam was spectacular, he decided. But the Universe was filled with spectacular weapons and technologies.

Godel's theorem, though. That was something else. That was truly terrifying. Mace, young, unimaginative, had responded more to the blazing of a zap gun than to the fact of a Universe without bottom or top, without meaning, unknowable. Kapur almost envied him.

"I think I've figured it out," he said to Mace.

"What? Their motivation?" Through his fear, Mace looked briefly interested. "Tell me, policeman. I knew there had to be something; every sentient species has goals."

"We had the pieces of the puzzle, almost from the start," Kapur said. "In their design of the 'Flake, the Snowmen had already made near-optimal use of matter, by recording information right down to the thermodynamic limit... which is set by the background temperature of the Universe. But they knew from Godel that there will always be more events to record."

Mace's face crumpled sourly. "Oh. Are you telling me that they are waiting for the Universe to cool down... just so they can store more data?"

Kapur smiled. "The idea is pleasing. In the aeons since the building of the Snowflake, they've already achieved a

six-fold increase in capacity! And in another forty billion years the capacity will double again...

"Patience, Mace. That is the key."

Mace stared into Kapur's face, the lines around his Eyes betraying hostility. "Policeman, sometimes you frighten me."

Kapur, obscurely pleased by this reaction, did not reply. Mace said, "Do you think there'll be another attempt?"

"To Assimilate?" Kapur shook his head. "I doubt the 'Flake would let us come so close again."

He turned to face the emptiness of the viewport. With eyes no more than human he looked beyond the filmy sails of the laser yacht and saw the Spline coming to collect them. It moved cautiously, all weapons orifices open.

*Over centuries and a million battles, mankind moved into a position of something like dominance over its peers. And it began to confront the Xeelee, who moved through space like ships over the surface of an ocean.*

*Gradually, slowly, humans probed the great projects of the Xeelee. A hundred epic quests were undertaken, a hundred names thrown up to resonate through the long afternoon of human history...*

*And over a hundred devastated human worlds, Xeelee fighters folded night-dark wings.*

# Vacuum Diagrams

**A.D. 21124**

Paul opened his eyes.

His body ached. He lay facedown on a surface that glowed with white light. Grass, or fine hair, washed over the surface.

*What is this place? How did I get here? And...*

*What's my name?*

His face grew slick with sweat; his breath sawed through his mouth. He perceived the shape of answers, like figures seen through a fog. He writhed against the shining ground.

The answers floated away.

A meaningless jingle ran around his mind: "We're here because we're here because we're here because we're here..."

The grass vanished. He waited, hollow.

Three men walked slowly through Sugar Lump City. Paul trailed Taft and Green, their urgent talk washing past his awareness. The sights, sounds and smells of the new City poured into his empty memory.

The embryonic street was lined with blocky buildings of foamed meteorite ore. Most of the buildings were still dark, silent. Paul passed a construction site. Huge machines with ore spouts like mouths clawed aside meteorite debris and sprayed out floors and walls. The cold air was filled with dust, the stink of machine oil -- and an incongruous tang of fresh-cut wood. Four workmen stalked around the site, shouting at the huge devices which did their bidding.

Taft and Green had paused at the knee-high lip of a light well. Paul joined them and peered into the well. The exposed surface of the Sugar Lump, twenty feet down, was a shining disc. A beam of light thrust straight up from the well and splashed against curved mirrors above their heads, illuminating the surrounding streets.

Shadows passed beneath the exposed plane like fish in a light-filled pond.

The sky was blue-black. Above the City's thin layer of air Spline warships prowled, visibly spherical.

Paul felt he was floating, suspended between mysteries above and below.

"Coexistence with the Xeelee," Taft was saying. "That's what the colony is about. The meteorite impact which smeared rock over this Face of the Lump was a miraculous break. By terraforming this region and colonizing it we can prove to the Xeelee we don't have to go to war with them." He was a tall, heavily-built man of about physical-forty; the well's under-lighting gave his bearded face a demonic power, and when his metallic Eyes fixed on him, Paul felt a psychic shock.

"And isn't your mysterious waif here going to endanger that?" Taft demanded.

...And one day, Paul realized, this man would try to kill him. He edged closer to Commander Green.

Green interposed his short, blocky frame between Taft and Paul. Well light glittered from his ornate Navy epaulets. "Your colonization project isn't under question at present, Dr. Taft," he said briskly.

"Isn't it?" Taft raised bushy eyebrows. "Then call off your Spline war dogs. Spend your resources on my terraforming efforts down here."

Green spread callused hands. "Let's stick to the point, shall we? You know I don't have the authority to call off the exclusion fleet. And those who do are unlikely to withdraw

as long as there's so much mystery, so much threat associated with the Sugar Lump."

Taft snorted. "Threat? The government acts like a bunch of superstitious fools every time the Xeelee are mentioned. Look, Green, we've made a lot of progress. We've established that the Lump is an artifact, fabricated from Xeelee construction material--"

"And that's about all you have established," Green said with a touch of steel. "Despite the money you've spent so far."

"Commander, Xeelee construction plate isn't tissue paper. You can't just cut a hole in it."

"I know that. So it seems to me that Paul here -- with his proven non-local perception abilities -- is our best hope of getting some hard data." He winked at Paul. "What I fail to see is what threat Paul represents to you."

Taft stared at Paul. Well light glittered over his metal Eyes, and again Paul was flooded with a nameless fear. "I won't discuss this in front of the boy," Taft said.

Paul worked to keep his voice level. "I'd like to hear what you have to say. And I'm not a boy, Doctor. Physically I'm twenty years old."

Green grinned, showing even teeth. "Good for you."

"Damn it, Green, we don't know anything about this -- boy -- of yours. He's found in a fouled, ill-fitting pressure suit on the exposed Face at the edge of the City. Nobody knows who he is, or how he got there -- including Paul himself, so he says--"

"His amnesia is genuine," Green broke in. "And as to how he got to the Lump -- Taft, have you ever traveled on a Spline ship?"

Taft glared at him. "Do I look like a Navy goon?"

"A Spline warship," Green said patiently, "is a living creature. A sphere miles across. Its human crew occupy chambers hollowed out of the stomach lining. A Spline ship

is a big, complex, disorderly place. If Paul was a stowaway he won't have been the first--"

"He's an unknown," Taft insisted. "And by introducing him into this situation we incur an unknown risk."

"But what's beyond question is his bizarre, quantum-mechanical perceptive faculty. He represents an enormous opportunity."

Taft folded his arms and stared into the light well. "Suppose I refuse to cooperate?"

"I have sufficient authority to force you, frankly," Green said quietly. "Officially this is a war zone."

"I'll go over your head."

"I could have you arrested. Requisition your staff. Doctor, you haven't much choice."

Slowly, Taft nodded. "You're right, Commander. I don't have any choice. For the present." And he shot another savage metallic glance at Paul.

"I'm glad we agree," Green said dryly. "Now, I believe you've a plan to have Paul taken to an Edge. That seems a good idea."

Taft nodded reluctantly. "And if necessary we could go on to a Corner Mountain."

"We?" Green asked suspiciously.

Taft indicated the construction site a few yards away. The four workmen had gathered around a machine which had shattered a nozzle against a stubborn lump of rock. "You can see how busy we are," Taft said. "I'm not going to sacrifice my schedules for this -- venture. I'll accompany the boy myself."

The four workers sang softly as they hauled at the broken nozzle. Paul strained to hear their words, struck by an unaccountable feeling of significance.

Green said carefully: "Of course I'll escort you both."

"As you wish."

"Well, shall we start?"



The words of the work song drifted through the cold air: "We're here because we're here because we're here because we're here..."

Paul stood transfixed. The words echoed around his head.

Green touched his arm. "Paul? Are you okay?"

Paul turned with difficulty. Green's lined face was reassuring. "That song," Paul said. "What does it mean?"

Green listened for a few seconds, then chuckled. "Paul, soldiers and sailors have been singing that for centuries. Whenever they're forced to do something they don't particularly like. The tune's called 'Auld Lang Syne'. It's thought to predate the Qax Occupation..." He searched Paul's face. "Have you heard it before?"

"I... don't know. Maybe."

Green smiled sadly. "Come on. Let's catch up with Taft before he has us thrown off the Lump."

Taft escorted them to a car at the edge of the City.

The air here seemed colder and thinner. Raw meteorite material, scorched and fragmented, crunched under Paul's feet. On the horizon the Face of the Sugar Lump lay naked, as still and flat as a sea of light -- a sea which stretched thousands of miles until it plummeted over an Edge, as if over some huge waterfall of photons.

Twin cables ran over the debris and out over the Face. "We've laid cables across all the Lump's Faces, and along the Edges," Taft said with an ironic smile. "We've wrapped up this huge mystery like a birthday parcel, eh, Paul?" He opened up the car. It was a cylinder about forty feet long which clung like a glassy insect to its cables. Most of the hull was transparent, and it contained two rows of five large seats which were suspended from complex sets of gimbals. Taft helped Paul settle; straps were passed over his shoulders and around his waist, giving him a vicarious sense of security.

Taft took a seat near the front end of the car, before an instrument panel which centered on a small joystick. Taft pushed the stick forward and, with a jolt, the car began to pull itself along the cables.

They crawled out of the City's dome of atmosphere. The sky's deep blue faded, exposing hard stars. Spline ships drifted past the stars, diamond sharp.

The dark meteorite material grew sparse, and soon they were sailing smoothly over a glowing ocean. Occasional shadows, faint and miles across, washed from horizon to horizon.

Taft opaqued the hull, turning the car into a comfortable bubble of normality. Paul clung to his straps and settled into an uneasy sleep.

Light returned in a flood. Paul snapped awake... and screamed.

His chair had swiveled back on its gimbals. The nose of the car had tipped up through at least ten degrees. Outside, the Sugar Lump had tilted, too. He was falling backwards--

Green stood before him. "Paul. Stop it. You're perfectly safe."

His throat was tight; he gulped for breath. "What's happening?"

He heard Taft laugh. "I've told the damn kid what to expect on this trip."

"Then tell him again," Green snapped. He turned and, clinging to handholds, made his way to the car's small galley area.

Taft reclined comfortably in the drive chair. He was eating a small peach; gobbets of orange flesh clung to his beard. "I didn't realize your memory continues to fail, mystery boy--"

"Skip it, Taft," Green said casually.

Taft took another bite at his fruit. "Very well. Look, Paul, the surface on which the colony sits is utterly flat. The center of gravity of the Sugar Lump is somewhere beneath the center of the plane. The air we've been burning out of the meteorite material is attracted towards the center of gravity, so it clings to the middle of the plane as a kind of low dome. But now we've climbed away from the air and we're being pulled back to the center of gravity. So your chair swivels until it points straight down to the center -- but that means it's at an angle to the plane's local vertical. We seem to be climbing up an incline. By the time we get to the Edge we'll appear to be climbing at almost forty-five degrees. See?"

Paul twisted in his chair until he could look back the way the car had climbed. The twin cables were geometrically perfect lines laid over a shallow, glowing slope. Thousands of miles distant, covered by a blue dome of air, the brownish meteorite debris lay splashed over the unblemished plane.

It looked as if the whole arrangement should slide off into space.

Paul shuddered and turned away. Green stood awkwardly on the tilting floor, sipping a coffee. "How do you feel? Better?"

Paul shrugged. "How should I feel? Commander, the Sugar Lump has been strong enough to withstand a major meteorite impact. Without so much as a scratch. How am I going to get through it?"

Green ran a hand over his closely-cropped, graying hair. "Paul, the Xeelee always build big. And tough. I'll tell you about Bolder's Ring sometime... what I'm saying is that the awe you feel won't go away. But you'll get used to it.

"And remember, you're not a meteorite. You're not trying to blast your way through." He lowered his voice. "And that's been Taft's mistake. He's fired off lasers, projectiles, particle beams -- like a stream of little

meteorites, yeah? And the success he's had is precisely zero.

"You're different, Paul." Green leaned forwards, his expression a crumpled mixture of compassion and fascination. "You've this extraordinary talent. You're not unique; I don't want you to think that." He smiled. "None of us has any doubts about your humanity... and all of us share your faculty, your quantum-mechanical way of seeing things, to some extent. Did you know that the dark-adapted eye, even without augmentation, can pick up a single photon? So straightforward human senses can perceive events at the quantum level. And there's speculation that consciousness itself is a quantum process... What's different about you is the strength of this -- talent. The rest of us live here in the macro world, this smoothed-over mock-up of the truth. But sometimes you can see beyond the approximations and shams; you seem to be able to see right down to the fundamental level of quantum wave functions." Green's voice grew intense. "You see, Paul, in Taft's Universe the surface of the Lump is certain to keep out a meteorite. But in your Universe nothing is certain."

Paul twisted away. "I don't want to be uncertain, Commander. I'm frightened. I don't even know my real name."

Green grasped his shoulders. "Look, Paul, you are a puzzle to us. There's no point pretending otherwise. But the parts of the puzzle have to be connected. Where you came from must be connected with the way you are. And by doing this thing, by extending your talent to its limits, I believe you're going to discover more than what the Xeelee are up to inside the Sugar Lump. I believe you'll discover yourself."

Paul found himself shuddering. He tried to concentrate on the straps around his waist, the reassuring hands on his shoulders.

"Yeah," Taft said slyly. "Or maybe you'll discover you're nothing more than a vacuum diagram. What about that, eh, Paul?"

"A what?"

"Shut up, Taft."

"Come on, Commander. If this is a revision class, then let's revise it all." Taft stepped up to stand before Paul, grinning, brittle with bitterness. "You told me how you took Paul up to the Spline fleet, put him through a crash course on how to be a human. Well, what about your quantum physics, Paul? Remember Feynman diagrams? Those cute pictures which show particles interacting, living, dying?"

"Taft..." Green growled.

"Well, now, here's a remarkable little interaction. From out of nowhere pop three particles -- a pion, a proton, and an antineutron. Of course conservation is violated all over the place -- but thanks to the Uncertainty Principle nothing is absolute in this Universe. I presume that's the concept our naval friend was groping for just now. And then the diagram closes up. The three particles recombine -- they disappear back into the vacuum again, and conservation is reasserted. What a relief!

"But what really happens is that the antineutron is created at that final impact and moves *back* through time to initiate the creation of the other particles! Bizarre enough for you? And so this particular Feynman picture is a closed loop. A vacuum diagram. The particles come from nothing and return to nothing." He grinned. "We're here because we're here because--"

Green raised one massive uniformed arm, pushed Taft away easily, muttered something Paul couldn't hear.

Paul closed his eyes, hoping to make the incomprehensible Universe disappear into the vacuum from which it had sprung.

The approaching Edge was a knife-blade across the stars. The car climbed the one-in-one slope ever more slowly, finally stopping a hundred yards from the rim. "Come on, Paul," Green said. "We walk from here." Briskly he helped Paul seal himself into a light, one-piece pressure suit. "And go easy. Remember we're that much further from the Lump's center of mass; gravity is only about half what it is in the City."

Paul climbed through the car's membranelike airlock. A handrail had been bonded to the surface a few yards from the car. Paul stumbled towards it. The apparent forty-five-degree slope was without purchase, and his motions felt slow and dreamlike, as if he were underwater.

Clinging closely to the rail he turned and surveyed the Sugar Lump.

Beneath his feet was a hillside of glowing glass. Shadows bigger than cities moved through it. Paul knew the Face was a square six thousand miles to a side, and he had half-expected to see details of far Edges and Corners from this vantage point; but beyond a few hundred miles the surface collapsed in his vision into a single, shining line of light. Sugar Lump City was a low dome of blue, improbably clinging to the center of the line.

"Paul," Green said softly. "Look up."

Paul craned his neck. A Spline warship swooped overhead, no more than ten miles from the Edge. Paul could make out valley-sized wrinkles in the fleshy sphere, weapon emplacements twinkling in deep pocks. Finally the warship sailed over the Edge of the world, rolling grandly.

"They know we're here," Green said. "That was a salute roll."

His voice seemed to come to Paul from far away. A sense of distance swept over him; it was as if he were shrinking, or as if the Universe were receding in all directions.

"Paul?... Are you okay?"

"What's wrong with him? Damn it, the kid's a liability."

"Take it easy, Taft. Sometimes this state of semifaint is a prelude to his heightened awareness phases. Come on, help me get him to the Edge."

The words swam by like fish. Green and Taft stood to either side of him, grasping his arms. They were figures of wood and paper, moving with dry rustles. The light of the Lump burned through them.

At last they stood in a line on the rim of the world. The Edge was an arrow-straight ridge, with the two identical Faces falling away on either side. It was like standing on the roof of some huge house. Cables had been laid along the Edge; a second car clung to them. Bundles of maintenance equipment had been fixed to the surface close to the car site.

"I hope this trip was worth it," Green said, panting.

Taft barked laughter. The sound was like a dry leaf crumpling. "Well, you asked for my guidance and you got it. Obviously the stresses on the material are higher here than close to the center of a Face. So if your wonder boy is going to gain access he has as good a chance here as anywhere. Watch out for the Edge itself, though. It's sharp as a knife, down to the finest limits we can perceive."

"No," Paul said.

Green and Taft stared at him, releasing his arms. With the loss of physical contact they became still more insubstantial, receding from his vision like ghosts.

He knelt awkwardly and ran a gloved finger along the Edge. The stuff was soft; it rippled. It was like running a hand through a fine, multicolored grass.

Words like "sharp" were meaningless, of course; wooden words used by macro-men.

Green had given him the language to understand what he was perceiving: that this was the fundamental level of reality, the grain of quantum-mechanical probability wave functions.

An event was like a stone thrown into a pond; probability functions -- ripples of what-might-be -- spread out through space and time. Macro-men might see the pale shadows where the waves were thickest.

And that was all.

Their hard language of "particles" and "waves" and "here" and "now" reflected their limited perception, stony words to describe shadows. But he, Paul, the boy with no past, could sometimes see the entire surface of the pond -- and even catch hints of the depths which lay below.

He watched wave functions ripple away from the Edge, diminishing softly into prismatic shades of improbability, and felt his consciousness drawn out like a sword from its scabbard. He looked down at his body, bent awkwardly in its ill-fitting pressure suit; at the two stick men standing over it, obviously blind to the kaleidoscopic probability sparkles all around them.

The Face of the Sugar Lump was a window. He drifted through it.

He floated like a snowflake, wafted by probability winds. The Sugar Lump was full of wonders.

Here was an array of crystals which would grow at a touch into a fleet of a thousand night fighters, unfurling glistening wings like dark butterflies. Twist this flowerlike artifact just so and a city would unfold in a storm of walls and ceilings. Point this other at a star -- and watch it collapse softly into nova.

And here, rank on rank of shadowy forms, were Xeelee themselves, features smoothed-over and indistinct, embryonic.

The Sugar Lump was a seed pod.

Something watched him. Paul twisted, scattered his being like diffusing mist...

Call it the antiXeelee.



It was as old as the Xeelee race, and as young. Inside the vessel men called the Sugar Lump -- and, simultaneously, within a million similar vessels scattered through the galaxies -- it waited out aeons, brooding.

The antiXeelee took Paul as if in the palm of a hand. Paul tried to relax. The gaze was all-knowing, full of strength... but not threatening.

Gently he was shepherded to the gleaming walls and released.

He opened his eyes. And moaned.

He was back in the world of the stick men.

Green's face, lined with concern, hovered before him. "Take it easy," he said. "We've brought you inside the Edge car." He slid a hand behind Paul's neck, tilted his head forward and helped him sip coffee. "How do you feel?"

Paul felt the softness of the seat beneath him, saw the warm brown light of the car interior. Beyond the windows the glow of the Sugar Lump seemed different. Harsher? Sharper? Shadows raced through the interior. "What's happening, Commander? Where's Taft?"

"At the controls of the car. He got a call from his team at the City site; some kind of problem." Green leaned over him hungrily. "Paul. You were inside the Lump, weren't you?"

"...Not really. It isn't like that." Paul reached for the coffee cup and took another mouthful. "You taught me what's happening. I have a non-local perception. Like a quantum wave function I'm not limited to the here and now; I perceive events spacelike-separated from--"

"Paul," Green said urgently, "skip it. Tell me what you saw. I have to know. My career is hinging on this moment. *Is it the Xeelee?*"

"I... Yes. It's the Xeelee." He groped for analogies. "It's like a huge hangar in there. There are Xeelee, waiting, whole populations of them. Thousands of ships, ready to be -- ripened. Artifacts of all kinds."

Green smiled. "Weapons?"

"Yes." Over Green's shoulder Paul could see Taft approach quietly.

"What are they doing?"

"I don't know. But, Commander, I don't think they mean us any harm. You see, there's another presence which--"

Taft's bearded face was twisted with a kind of pain. He raised two clasped fists over Green's head.

"Commander!" Paul jerked convulsively.

Green half-rose, turned his head. Two fists hit his skull with a sound like wood on wood. The reaction carried Taft perhaps a foot into the air. He cried out. His hands came away bloody.

Green tumbled into Paul's lap; then he slid to the floor of the car.

Paul stared at the blood on Taft's hands. Memories stirred impossibly. *So it is coming to pass, as I knew/remembered.* But how...?

"Paul, I--" Taft spread his hands, palms upwards. Paul couldn't read his face, the shining artificial Eyes. "I'm sorry. I have to do this." With clumsy hands he fitted Green's helmet into place and sealed the neck; then he began hauling the huge, limp body towards the airlock. "My team back in the City are being evacuated. Forcibly, by Green's damnable Navy goons."

"Why? What's happened?"

"You've stirred up the Xeelee with your quantum jaunt," Taft said acidly. "The glow of the surface is brighter. And it's getting hotter. In some places the meteorite debris is already red hot. So we're being evacuated -- at the point of a gun." Taft sealed up his own helmet. "So I've got to stop this, you see, Paul. I'm sorry. It's for the good of the species. The Xeelee have to understand we're not continually going to attack them. The colony has to be built."

"What are you going to do?"

"I'm going to get Green back to the Face car. Then I'll return here and--"

Paul felt his breath grow shallow. "And what?"

Without replying Taft turned away and stepped through the airlock; the membrane closed behind Green's booted feet.

Paul sat for long minutes. The humming of the car's instruments was the only sound. Through the windows Taft and Green were silhouetted against a glowing Face, the pair of them looking like a single, struggling insect.

Paul imagined Taft's return, those bloodied, space suited hands reaching for him, as they had for Green--

There was a joystick at the front of the car.

He pushed himself out of his chair and stood swaying. He took cautious steps along the narrow aisle, looking neither to left nor right.

Nervously he pushed at the joystick. The car lurched a few yards; Paul stumbled back, grabbing the arm of the nearest chair. He felt a grin spread over his face. Had Taft expected him to sit patiently and wait to die? He pushed the stick once more. Motors whirled and the car slid along the Edge.

Taft dumped Green's inert form and came floundering back up the slope, a toy figure gesturing in tiny frustration.

Paul settled into a seat and let the satisfaction of the small victory settle over him. There would be plenty of time to face the future later... when the car reached Corner Mountain, with nowhere else to go.

The car patiently climbed the Edge's increasing slope. The brightness of the Faces continued to increase; at last the car's lower windows opaqued automatically.

Paul could see Taft following, a silver-suited doll riding an open maintenance buggy up the dizzying slopes of the Edge. For the first few hours Paul let Taft speak to him.

When the half-rational arguments turned to sobbed pleas for understanding Paul snapped the radio off.

The Corner Mountain became visible as a sharp angle against the stars. The car slowed to a halt, tipped up at about thirty-five degrees.

Paul closed his helmet and stepped through the airlock. His footsteps were light, airy; Green had told him how, this far from the mass center of the Lump, gravity would be down to a third that at the City. The brilliance of the surface hit him with a soft impact. Heat soaked through the soles of his boots. With an odd sense of calm he worked his way up the slope to the summit, his feet on the tilted surfaces to either side of the Edge.

At last he stood unsteadily at the summit itself, feet wrapped around the sharp-edged point, arms extended for balance. The vertical lurched around him as his inner ear sought the way to the center of mass of the Sugar Lump.

Taft had abandoned his vehicle and was scrambling up the dazzling ridge. Paul felt a huge peace, as if he were once more in the metaphorical palm of the antiXeelee. He turned slowly, feet working around the summit. Three square Faces as wide as Earth shared corners at the point where he stood; he saw Edges disappear into infinity, watched Faces collapse into glowing lines of abstraction.

Sugar Lump. Edge. Corner Mountain. He found himself laughing. Harmless words used to shield men from the astonishing truth of a world shaped like a cube, of a made thing whirling and sparkling in space.

Taft stood before him. The light showed him to be a machine of pulleys, cables and gears; quantum functions sparkled unnoticed around his eyes and fingers.

Paul smiled. And jumped backwards.

Taft stumbled forward, reaching. Then he was gone, eclipsed by an Edge.

Paul let his limbs dangle. Spline warships paddled across his view like agitated fish.

He was approaching a glowing Face. What next? Would he strike, bounce away, proceed skipping and sliding? Would the impacts crush his bones? Would the heat of the surface reach through the suit and boil his flesh?

The certainty of his death was unreal, intangible, unthreatening.

Now, why should that be? Was his death to be as great a mystery as his origin? Would he die ignorant of the answers of both the great questions of his existence -- *where did I come from?* and *where am I going to?*

Or perhaps the two answers were somehow linked...

He found he hoped Taft and Green would survive.

The Face rushed at him. Wave functions rippled like grass in a breeze.

Folded ships hung around him like moths.

There was a sense of motion, a thrumming of huge engines somewhere; as if the Sugar Lump and its contents were a great liner, forging through some huge sea.

The antiXeelee cradled him. It studied him dispassionately, huge and cold. Paul felt knowledge wash over him, and slowly understanding grew.

The cube planet had been created at that moment -- far in the future of mankind -- when the Xeelee reached their full glory. And were ready to depart.

(Depart? Where to? Why? The answers were -- awesome; beyond his comprehension.)

On its completion the cube -- with its guardian, the antiXeelee, and with a million others -- had been sent on an impossible voyage, forging back through the unfolding ages to the birth time of the Xeelee themselves. The Xeelee would erupt fully developed from the cubes, shaking out the wings of their beautiful spacecraft and ready for their huge projects. Paul sought human words to capture the vast concepts sailing around him. Vacuum diagrams! The cube worlds were antiparticles, moving back through time

to initiate their own creation. The whole of Xeelee history was a single, vast vacuum diagram, closed and complete of itself.

*But... what of me?*

Now Paul sensed a monstrous amusement. He was cupped within gigantic palms for an unmeasurable period; the time engines surged steadily into the past--

And then he was lifted up and released like a captive bird.

He looked down. He was outside the Sugar Lump, falling towards it. Spline ships converged. There was the City, still alive with the hopes of Taft and the rest, spreading over the meteorite debris. On the rim of the debris was a fallen figure, a young man in a soiled spacesuit lying facedown on the glowing surface.

Understanding came at last.

*I have no beginning. I have no end. My lifeline is caught up in the vast Xeelee expedition into the past. I am a vacuum diagram, too, closed on myself.* He remembered the absurd refrain: "We're here because we're here here because we're here..."

He tumbled into the head of the fallen man. Skull darkness hit him like a physical shock, and he felt the pieces of his understanding shatter like a dropped vessel, his memories seep away.

In the end he was left only with a vast amusement. Then even that fell away.

Paul opened his eyes.

His body ached. He lay facedown on a surface that glowed with white light. Grass, or fine hair, washed over the surface.

*What is this place? How did I get here? And...*

*What's my name?*

His face grew slick with sweat; his breath sawed through his mouth. He perceived the shape of answers, like figures seen through a fog. He writhed against the shining ground.

The answers floated away.

A meaningless jingle ran around his mind: "We're here because we're here because we're here because we're here..."

The grass vanished. He waited, hollow.

*A hundred heroes, a hundred fragments -- but understanding did not come: What was the goal of the Xeelee? Why were they trying to rebuild their own history?*

*And what was the significance of Bolder's Ring? -- why were the Xeelee trying to escape from the Universe itself?*

*Like leaves, the centuries fell away. Humanity's growth in power and influence grew exponentially. But the legend of Xeelee achievements -- the manipulation of space and time, the Ring itself -- grew into a deep-rooted mythology.*

*At last, only the Xeelee themselves were more potent than mankind...*

*Humans railed against the Tyranny of Heaven.*

*More legends were written, as waves of human assaults pounded against the great Xeelee sites. It was a remote, inhuman time. I watched, repelled, terrified.*

## **PART 5**

### **ERA: The War to End Wars**

*Fragments. Shards...*

*Humans even reached into the Prime Radiant of the Xeelee.*

*Here was a warship, its engine blazing, falling through Bolder's Ring -- and into a new Universe.*

*The ship imploded, and fell into a compact, glowing nebula. Crew members hurried through the corridors of their falling ship; smoke filled the passageways as lurid flames singed the air. The hull was breached; the raw air of the nebula scoured through the cabins, and through rents in the silver walls the crew saw flying trees and huge, cloudy whales, all utterly unlike anything in their experience...*

*Gradually they came to understand. Gravity was the key to the absurd place they were stranded in. Gravity here was a billion times as strong as in the Universe they'd come from. Here their home planet would have a surface gravity of a billion gees -- if it didn't implode in an instant.*

*The crew adapted, and survived. Gradually humans spread through the nebula...*



## **Stowaway**

**A.D. 104,858**

It was the end of Rees's work shift. Wearily he hauled himself through the foundry door. Cool air dried the sweat from his brow.

He pulled himself along the ropes and roofs towards his cabin, inspecting his hands and arms with some interest. When one of the older workers had dropped a ladle of iron, Rees had narrowly dodged a hail of molten metal; tiny droplets had drifted into his flesh, sizzling out little craters which--

A huge shadow flapped across the Belt. Air washed over his back. He looked up; and wonder settled at the base of his skull.

The tree was a wheel of wood and foliage fifty yards wide, magnificent against the crimson sky. Its dozen radial branches and their veil of leaves turned with a calm possession; the trunk was like a mighty wooden skull which glared around at the ocean of crimson air.

Its rotation slowing, the tree lowered itself reluctantly into the gravity well of the star kernel.

Pallis, the tree-pilot, was hanging by hands and feet below the knotty trunk of the tree. The star kernel and its churning Belt mine were behind his back. The Belt itself was a circle eight hundred yards wide, a chain of battered dwellings and work places connected by ropes and tubes. At the center of the Belt was the mine itself, a cooled-down star kernel a hundred yards wide; lifting cables dangled from the Belt to the surface of the star kernel, scraping the rusty meniscus at a few feet per second. Here and there,

fixed to the walls and roofs of the Belt, were the massive, white-metal mouths of jets; every few minutes a puff of steam emerged from one of those throats and the Belt tugged imperceptibly faster at his heels, shaking off the slowing effects of air friction...

It was a spectacular sight, but it was of little interest to Pallis.

With a critical eye he peered up through the mat of foliage at the smoke which hung raggedly over the upper branches. The layer of smoke wasn't anywhere near thick enough: he could clearly see starlight splashing through to bathe the tree's round leaves. He moved his hands along the nearest branch, felt the uncertain quivering of the fine blade of wood. Even here, at the root of the branches, he could feel the tree's turbulent uncertainty.

Two imperatives acted on the tree. It strove to flee the deadly gravity well of the star -- but it also sought to escape the shadow of the smoke cloud, which drove it back into the well. A skillful woodsman should have the two imperatives in fine balance; the tree should hover in an unstable equilibrium at the required distance.

Now the tree's rotating branches bit into the air and it jerked upwards by a good yard. Pallis was almost shaken loose. A cloud of skitters came tumbling from the foliage; the tiny wheel-shaped creatures buzzed around his face and arms as they tried to regain the security of their parent.

*Damn that boy --*

He hauled himself through the foliage to the top side of the tree. The ragged blanket of smoke and steam hung a few yards above his head, attached tenuously to the branches by threads of smoke. The damp wood in at least half the fire bowls fixed to the branches had, he soon found, been consumed. And Gover, his so-called apprentice, was nowhere to be seen.

"Gover! By the Bones themselves, what do you think you are doing?"

A thin face appeared above one of the bowls near the rim of the tree. Gover shook his way out of a nest of leaves and came scurrying across the platform of foliage, a pack bouncing against his narrow back. He shoved the back of his hand against his nose, pushing the nostrils out of shape; the hand came away glistening. "I'd finished," he mumbled.

Pallis stabbed a finger at Gover's pack. "You're still carrying half your stock of wood. The fires are dying. And look at the state of the smoke screen. More holes than your damn vest. My tree doesn't know whether she's coming or going, thanks to you. Can't you feel her shuddering? Now *move it*."

With a flurry of motion Gover pulled himself to the nearest pot and began hauling wood from his pack. Soon fresh billows of smoke were rising to join the depleted cloud, and the shuddering of the tree subsided.

His exasperation simmering, Pallis watched the boy's awkward movements. Oh, he'd had his share of poor apprentices in the past, but in the old times most of them had at least been willing to learn. To try. And gradually, as hard shifts wore by, those young people had grown into responsible men and women, their minds toughening with their bodies.

But not this lot. Not the new generation.

This was his third flight with the boy Gover. And the lad was still as sullen and obstructive as when he'd first been assigned to the trees; when they got back to the Raft Pallis would be more than glad to hand him back to Science.

His gaze roamed around the red sky, restless.

The air of the Nebula was, as always, stained blood-red. A corner of his mind tried to measure that redness -- was it deeper than last shift? -- while his eyes flicked around the objects scattered through the Nebula above and below him.

The clouds were like handfuls of grayish cloth sprinkled through miles of air. Stars fell among and through the clouds in a slow, endless rain that tumbled down to the Core. It was as if he were suspended in a great cloud of light; the star-spheres receded with distance into points of light, so that the sky itself was a curtain glowing red-yellow. The falling stars were an array of pinpoints dwindling into the far distance; the depths of the Nebula, far below him, were a sink of murky crimson.

The light of the mile-wide stars cast shifting shadows over the clouds, the scattered trees, the huge blurs that might be whales. Here and there he saw a tiny flash that marked the end of a star's brief existence...

In his time, the world had changed around Pallis. The Nebula seemed to be choking up. The crisp blue skies, the rich breezes of his youth were memories now; the very air was turning into a smoky crimson sludge.

The world was dying, and no one knew why, or how to stop it.

And one thing was for sure. Pallis's trees didn't like this gloom.

He sighed, trying to snap out of his introspection. The stars kept falling no matter what the color of the sky. Life went on, and he had work to do.

A heavy cloud, fat with rain, drifted over the Belt, reducing visibility to a few yards; the air it brought with it seemed exceptionally sour and thin.

Rees prowled around the cables that girdled his world, muscles working restlessly. He completed two full circuits, passing huts and cabins familiar since his childhood, hurrying past well-known faces. The damp cloud, the thin air, the confinement of the Belt seemed to come together somewhere inside his chest.

Questions chased around his skull. Why were human materials and building methods so inadequate to resist the

forces of the world? Why were human bodies so feeble in the face of those forces?

His father used to say the mine was killing them all. Humans weren't meant to work down there, crawling around in wheelchairs at five gee.

Now his parents were dead.

Rees was still a boy. But he faced a prospect of nothing more than to labor in the kernel mines, to have his health broken by the monstrous gravity, to die young.

Shards of speculation glittered in the mud of his overtired thinking. His parents had had no better understanding of their circumstances than he had; there had been nothing but legends they could tell him before their sour deaths of overwork: children's tales, of a Ship, a Crew, of something called Bolder's Ring...

But his parents had had -- acceptance. They, and the rest of the Belt dwellers, accepted their lot.

Only Rees seemed plagued by questions, unanswered doubts. Why couldn't he be like everyone else? Why couldn't he just accept and be accepted?

His arms, punctured by hot metal, ached. A vague anger suffused him. Well, why *should* he accept this? Why should he die, broken-down by the five gee of the Star's kernel, without learning more, the truth of the world?

He had to find out more. And in all his universe there was only one place he could go to find it.

The Raft. Somehow he had to get to the Raft.

The shadow of the great tree slid over the Belt. A rope had uncoiled from the tree trunk and lay across the fifty yards to the Belt, brushing against the orbiting cabins. A man came shimmering confidently down the rope; he was scarred, old and muscular, almost a piece of the tree himself. The man dropped without hesitation across empty air to a cabin and began to make his way around the Belt.

A sudden determination crystallized in Rees. He hurried around the Belt to his cabin.

It took minutes to gather up some food, wrapping dried meat in bundles of cloth, filling cloth globes with water.

Then he climbed to the outer wall of his cabin.

Rees clung to his cabin by one hand. The rotation of the Belt carried the cabin steadily towards the tree's dangling rope.

As the rope approached, a thin sweat covered his brow. Was he somehow throwing his life away in this impulsive gesture? Would he, in the end, have the courage to take the decisive step?

Staring at the magnificent tree he probed at his emotions. There was no fear. There was only elation; the future was an empty sky, within which his hopes would surely find room.

When the rope was a yard from him he grabbed at it and swarmed without hesitation off the Belt.

A file of miners clambered up to the tree, iron plates strapped to their backs. Under the tree-pilot's supervision the plates were lashed securely to the tree rim, widely spaced. The miners descended to the Belt laden with casks of food and fresh water, delivered from the Raft in payment for the kernel metal.

Rees, watching from the foliage, stayed curled closely around a two-feet-wide branch -- taking care not to cut open his palms on its knife-sharp leading edge -- and he kept a layer of foliage around his body. He had no way of telling the time, but the loading of the tree must have taken several shifts.

He was wide-eyed and sleepless. He knew that his absence from work would go unremarked for at least a couple of shifts -- and, he thought with a distant sadness, it

might be longer before anyone cared enough to come looking for him.

Well, the world of the Belt was behind him now. Whatever dangers the future held for him, at least they would be new dangers.

In fact he only had two problems. Hunger and thirst...

Disaster had struck soon after he had found himself this hiding place among the leaves. One of the Belt workmen had stumbled across his tiny cache of supplies; thinking it belonged to the despised Raft crewmen the miner had shared the morsels among his companions. Rees had been lucky to avoid detection himself, he realized... but now he had no supplies, and the clamor of his throat and belly had come to fill his head.

When the final miner had slithered down to the Belt Pallis curled up the rope and hung it around a hook fixed to the trunk. He hated these visits to the Belt, the way he was forced to negotiate so hard with these ragged, half-starved miners. He shook his head and turned his thoughts with some relief to the flight home.

"Right, Gover, let's see you move! I want the bowls switched to the underside of the tree, filled and lit before I've finished coiling this rope. Or would you rather wait for the next tree?"

Gover got to work, comparatively briskly; and soon a blanket of smoke was spreading beneath the tree, shielding the Belt and its star from view.

Pallis stood close to the trunk, his feet and hands sensitive to the excited surge of sap. It was almost as if he could sense the huge vegetable thoughts of the tree as it reacted to the darkness spreading below it. The trunk audibly hummed; the branches bit into the air; the foliage shook and swished and skitters tumbled, confused at the abrupt change of airspeed; and then, with an exhilarating surge, the great spinning platform lifted from the star. The

Belt and its human misery dwindled to a toylike mote, falling slowly into the Nebula, and Pallis, hands and feet pressed against the flying wood, was where he was most happy.

His contentment lasted for about a shift and a half.

He prowled the wooden platform, moodily watching the stars slide through the silent air. The flight just wasn't *smooth*. Oh, it wasn't enough to disturb Gover's extensive slumbers, but to Pallis's practiced senses it was like riding a skitter in a gale. He pressed his ear to the ten-foot-high wall of the trunk; he could feel the bole whirring in its vacuum chamber as it tried to even out the tree's rotation.

This felt like a loading imbalance... but that was impossible. He'd supervised the stowage of the cargo himself to ensure an even distribution of mass around the rim. For him not to have spotted such a gross imbalance would have been like -- well, like forgetting to breathe.

Then what?

With a growl of impatience he pushed away from the trunk and stalked to the rim. He began to work around the lashed loads, methodically rechecking each plate and cask and allowing a picture of the tree's loading to build up in his mind--

He slowed to a halt. One of the food casks had been broken into; its plastic casing was cracked in two places and half the contents were gone. Hurriedly he checked a nearby water cask. It too was broken open and empty.

He felt hot breath course through his nostrils. "Apprentice! Come here!"

The boy came slowly, his thin face twisted with apprehension.

Pallis stood immobile until Gover got within arm's reach; then he lashed out with his right hand and grabbed the apprentice's shoulder. Pallis pointed at the violated casks. "What do you call this?"



Gover stared at the casks with what looked like real shock. "Well, I didn't do it, pilot. I wouldn't be so stupid -- ah!"

Pallis worked his thumb deeper into the boy's joint, searching for the nerve. "Did I keep this food from the miners in order to allow you to feast your useless face? Why, you little bone sucker, I've a mind to throw you over now..."

Then he fell silent, his anger dissipating.

There was still something wrong.

The mass of the provisions taken from the casks wasn't nearly enough to account for the disruption to the tree's balance. And as for Gover -- well, he'd been proven a thief, a liar and worse in the past; but he was right: he wasn't nearly stupid enough for this.

Reluctantly he released the boy's shoulder. Gover rubbed the joint, staring at him resentfully. Pallis scratched his chin. "If you didn't take the stuff, Gover, then who did? Eh?" By the Bones, they had a stowaway.

He dropped to all fours and pressed his hands and feet against the wood of a branch. He closed his eyes and let the tiny shuddering speak to him. If the unevenness wasn't at the rim, then where...?

Abruptly he straightened and half-ran about a quarter of the way around the rim, his long toes clutching at the foliage. He paused for a few more seconds, hands once more folded around a branch; then he made his way more slowly towards the center of the tree, stopping halfway to the trunk.

There was a little nest in the foliage. Through the bunched leaves he could see a few scraps of discolored cloth, a twist of unruly black hair, a hand dangling weightless; the hand was that of a boy or young man, he judged, but it was heavily callused and it bore a spatter of tiny wounds.

Pallis straightened to his full height. "Well, here's our unexpected mass, apprentice. Good shift to you, sir! And would you care for your breakfast now?"

The nest exploded. Skitters whirled away from the tangle of limbs and flew away, as if indignant; and at last a boy half-stood before Pallis, eyes bleary with sleep, mouth a circle of shock.

Gover sidled up beside Pallis. "By the Bones, it's a mine rat."

Pallis looked from one boy to the other. The two seemed about the same age, but where Gover was well-fed and ill-muscled, the stowaway had ribs like the anatomical model of a Scientist, and his muscles were like an adult's; and his hands were the battered product of hours of labor. The lad's eyes were dark-ringed. Pallis remembered the imploded foundry and wondered what horrors this young miner had already seen. Now the boy filled his chest defiantly, his hands bunching into fists.

Gover sneered, arms folded. "What do we do, pilot? Throw him to the Boneys?"

Pallis turned on him with a snarl. "Have you cleaned out the fire bowls yet? No? Then do it. Now!"

With a last, baleful glare at the stowaway, Gover moved clumsily away across the tree.

The stowaway watched him go with some relief; then turned back to Pallis.

The pilot raised his hands, palms upwards. "Take it easy. I'm not going to hurt you... Tell me your name."

The boy's mouth worked but no sound emerged; he licked cracked lips, and managed to say: "Rees."

"All right. I'm Pallis. I'm the tree-pilot. Do you know what that means?"

"I... yes."

"By the Bones, you're dry, aren't you? No wonder you stole that water. You did, didn't you? And the food?"

The boy nodded hesitantly. "I'm sorry. I'll pay you back--"

"When? After you return to the Belt?"

The boy shook his head, a glint in his eye. "No. I'm not going back."

Pallis frowned. "What about your parents?"

"They're dead. Both of them."

Pallis bunched his fists and rested them on his hips. "Listen to me. You'll have to go back. You'll be allowed to stay on the Raft until the next supply tree; but then you'll be shipped back. You'll have to work your passage, I expect..."

Rees shook his head again, his face a mask of determination.

Pallis studied the young miner, an unwelcome sympathy growing inside him. "Well, I'm stuck with you for now. Come on."

He led the boy across the tree surface, towards his little stock of rations.

After a dozen yards they disturbed a spray of skitters; the little creatures whirled up into Rees's face and he stepped back, startled. Pallis laughed. "Don't worry. Skitters are harmless. They are the seeds from which the trees grow..."

Rees nodded. "I guessed that."

Pallis arched an eyebrow. "You did?"

"Yes. You can see the shape's the same; it's just a difference of scale..."

Pallis arched an eyebrow. *Smart lad.*

The boy ate, as if he'd never been fed.

After letting the boy sleep for a quarter shift Pallis put him to work. Soon Rees was bent over a fire bowl, scraping ash and soot from the iron with shaped blades of wood. Pallis found that his work was fast and complete, supervised or un-supervised. Gover suffered by

comparison... and by the looks he shot at Rees, Pallis suspected Gover knew it.

Rees joined Pallis and collected his shift-end rations. The young miner peered absently around at the empty sky. As the tree climbed up towards the Raft, away from the Core and towards the edge of the Nebula, the air was perceptibly brightening.

"Come on," Pallis said. "Let me show you something."

He led the boy towards the trunk of the tree.

Surreptitiously he watched as the boy half-walked across the foliated platform, his feet seeking out the points of good purchase and then lodging in the foliage, so allowing him to "stand" on the tree. The contrast with Gover's clumsy stumbling was marked. Pallis found himself wondering what kind of woodsman the lad would make.

They reached the trunk. Rees stood before the tall cylinder and ran his fingers over the gnarled wood. Pallis hid a smile. "Put your ear against the wood. Go on."

Rees did so with a look of puzzlement -- which evolved into an almost comic delight.

"That's the bole turning, inside the trunk. You see, the tree is alive, right to its core."

Rees's eyes were wide.

Rees woke from a comfortable sleep in his nest of foliage. Pallis hung over him, silhouetted by a bright sky. "Shift change," the pilot said briskly. "Hard work ahead for all of us; docking and unloading and--"

"Docking?" Rees shook his head clear of sleep. "Then we've arrived?"

Pallis grinned. "Isn't that obvious?"

He moved aside. Behind him the Raft hung huge in the sky. A single star was poised some tens of miles above the Raft, a turbulent ball of yellow fire a mile wide, and the huge metal structure cast a broadening shadow down through miles of dusty air.

Under Pallis's direction Rees and Gover stoked the fire bowls and worked their way across the surface of the tree, waving large, light blankets over the billowing smoke. Pallis studied the canopy of smoke with a critical eye; never satisfied, he snapped and growled at the boys. But, steadily and surely, the tree's rise through the Nebula was molded into a slow curve towards the rim of the Raft.

The Raft grew in the sky until it blocked out half the Nebula. From below it showed as a ragged disc a half-mile wide; metal plates scattered highlights from the stars and light leaked through dozens of apertures in the deck. As the tree sailed up to the rim the Raft foreshortened into a patchwork ellipse; Rees could see the sooty scars of welding around the edges of the nearer plates, and as his eye tracked across the ceilinglike surface the plates crowded into a blur, with the far side of the disc a level horizon.

At last, with a rush of air, the tree rose above the rim and the upper surface of the Raft began to open out before Rees. He found himself drawn to the edge of the tree; he buried his hands in the foliage and stared, open-mouthed, as a torrent of color, noise and movement broke over him.

The Raft was an enormous dish that brimmed with life. Points of light were sprinkled over its surface. The deck was studded with buildings of all shapes and sizes, constructed of wood panels or corrugated metal and jumbled together like toys.

A confusion of smells assaulted Rees's senses -- sharp ozone from giant machines around the rim, wood smoke from a thousand chimneys, the hint of exotic cooking scents from the cabins. And *people* -- more than Rees could count, so many that the Belt population would be easily lost among them -- people walked about the Raft in great streams; and knots of running children exploded here and there into bursts of laughter.

He made out sturdy pyramids fixed to the deck, waist-high. And out of each pyramid a cable soared straight upwards; Rees tilted his face back, following the line of the cables, and he gasped. To each cable was tethered the trunk of a tree. To Rees one flying tree had been wonder enough. Now, over the Raft, he was faced with a mighty forest. Every tethering cable was vertical and quite taut, and Rees could almost feel the exertion of the harnessed trees as they strained against the pull of the Core.

A hundred questions tumbled through Rees's mind. What would it be like to walk on that metal surface? What must it have been like for the Crew who had built the Raft, hanging in the void above the Core?

But now wasn't the time; there was still work to do. Pallis was already bellowing at Gover. Rees got to his feet, wrapping his toes in the foliage like a regular woodsman.

Pallis joined him, and they labored at a fire bowl together.

"Rees, you can't have had any real idea what the Raft is like. So... why did you do it? What were you running from?"

Rees considered the question. "I wasn't running from anything, pilot. The mine is a tough place, but it was my home. No. I left to find the answer."

"The answer? To what?"

"To why the Nebula is dying."

Pallis studied the serious young miner and felt a chill settle on his spine.

How much education did the average miner get? Pallis doubted Rees was even literate. As soon as a child was strong enough he or she was forced into the foundry or down to the crushing surface of the iron star, to begin a life of muscle-sapping toil...

And the Belt's children were forced there by the economics of the Nebula, he reminded himself harshly; economics which he -- Pallis -- helped to keep in place.

He shook his head, troubled. Pallis had never accepted the theory, common on the Raft, that the miners were a species of sub-human, fit only for the toil they endured. What was the life span of the miners? Thirty thousand shifts? Less, maybe half of Pallis's own age already?

What a fine woodsman Rees would make... or, he admitted ruefully, maybe a better Scientist.

A vague plan began to form in his mind.

Maybe Pallis could help Rees find a place on the Raft.

It wouldn't be easy. Rees would face a lifetime of hostility from the likes of Gover. And the Raft was no bed of flowers and leaves; its economy, too, had declined with the slow choking of the Nebula.

But Rees deserved a chance. And Rees was a smart kid. Maybe, Pallis mused, just maybe he might actually find some answers. Was it possible?

"Now, then, miner," Pallis said briskly, "we've got a tree to fly. Let's get the bowls brimming; I want a canopy up there so thick I could walk about on it. All right?"

The tree had passed the highest layer of the forest. The Raft turned from a landscape into an island in the air, crowned by a mass of shifting foliage. The sky above Rees seemed darker than usual, so that he felt he was suspended at the very edge of the Nebula, looking down over the mists surrounding the Nebula's Core.

And in all that universe of air the only sign of humanity was the Raft, a scrap of metal suspended in miles of air.

His heart lifted, bursting with the exhilaration of a thousand questions.

*"Did Rees find his answers?"*

*Eve just smiled, and the images, of the glowing Nebula and its mile-wide stars, faded from my view, receding into a scrap of crimson light, a spark lost in the greater blaze of human history...[\[5\]](#)*

*The assaults continued, waves of them, generations of humans battering against the great Xeelee defenses... and leaving shards of humanity stranded in the great spaces around the Xeelee Prime Radiant.*

*At last, even those broken shards became weapons of war.*



# The Tyranny of Heaven

**A.D. 171,257**

We may with more successful hope resolve  
To wage by force or guile eternal war  
Irreconcilable to our grand Foe,  
Who now triumphs, and in the excess of joy  
Sole reigning holds the tyranny of heaven...

*Paradise Lost, John Milton*

Rodi climbed through the hatch and into the flitter. The craft was a box the size of a small room. He threaded his way through the interior.

There was a girl in one of the pilot seats. She turned. Tall and muscular, she wasn't much older than Rodi's twenty years.

Rodi tripped over a locker.

The girl's eyes glittered with amusement. "Take it easy. You're Rodi. Right? I'm Thet."

His face hot, Rodi took the seat beside her. "Glad to meet you." The instrument panel before him looked utterly alien.

"Well, buckle in." Thet punched fat buttons. Monitors showed muscles contracting in the Ark's hull. "And don't be so nervous."

"I'm not."

"Of course you are. I never understand why. You've taken flitters outside the Ark before, haven't you?"

"Sure." He tried not to sound defensive. "On inter-Ark hops. But this is my first mission drop -- my first time out of

hyperspace. It's a little different."

She raised fine eyebrows. "We didn't evolve in hyperspace."

"Maybe. But it's all I know--"

An orifice in the hull opened and exploded at them; the flitter surged into hyperspace. It was like being born.

A Virtual image of the Ark swam into their monitors. Holism Ark was a Spline ship: a rolling, fleshy sphere encrusted with blisters. It was a living being, Rodi mused, and it looked like it.

He wondered briefly what those blisters on the hull were. They couldn't be seen from within the Ark...

The flitter receded rapidly. Hyperspace smeared the Ark's image.

Now more Arks came into view. The flitter skirted islands of huge flesh as it worked its way through the fleet.

At last the flitter surged into clear hyperspace; Thet swung the flitter about.

Holism Ark was lost in a blurred wall of ten thousand Arks that cut the Universe in half. This was the Exaltation of the Integrality. Rodi imagined he could hear a thrumming as the great armada forged onwards; flitters skimmed between the huge hulls and rained into three-space.

"We're privileged to see this," Rodi said.

"Definitely," said Thet laconically. "A sight that hasn't changed for three thousand years." She snapped the flitter away; the Exaltation became a blur in the distance. Her shaven head gleamed in the cabin lights. "I'll tell you how we're privileged. After a hundred generations it's us who are around as the Exaltation reaches Bolder's Ring, the true Prime Radiant of the Xeelee. And so the sky here is full of lost human colonies. Bits of ancient, failed assaults. Instead of a dozen missionary drops a century we're getting a hundred a year. Which is why they're pressing almost anybody into service."

"Thanks," he said drily.

She grinned, showing teeth. "So I'm your tutor on your first drop. And I'm not what you expected. Am I?"

Rodi said nothing.

"Look -- I'm resourceful, a good pilot. I'm no great thinker, okay?... but you're different. Top marks in the seminary, Gren tells me. You should soon surpass me. And with all that understanding you should have no fear. The Integrality says that the death of an individual is unimportant."

"Yes." That was a child's precept; he clutched the thought and felt his anxiety recede.

"And you do believe in the Integrality. Don't you?" Her voice was sly.

Was she mocking him? "Of course. Don't you?"

She didn't reply. She stabbed at the control panel. The flitter popped out of hyperspace.

Stars exploded around him. Half of them were colored blue.

He gasped. Thet laughed.

*It's a simulation, he told himself. Just another sim.*

"I'm sorry," he said.

Thet watched with amused contempt. "Get your bearings."

The stars blurred together. Behind him they were tinged china blue. Ahead of him they formed a mist that hid... something, a hint of a torus shape--

"Bolder's Ring is ahead," he breathed.

"How do you know?"

Because that was the way everything was falling.

Thet said, "We've been space-going for a hundred and fifty millennia, probably. And yet we're still children at the feet of the Xeelee. Makes you sick, doesn't it?"

Rodi shrugged. "That's why we've been trying to wreck that thing for almost as long. Envy."

Thet paged through images on her monitor. "Shocking. And of course we of the Integrality are here to put it all right... ha! There's our goal." The screen contained a single spark of chlorophyll green. "Human life... or near enough to show up. A worldful of straying lambs. Right, Rodi?" And she drove the flitter through the crowd of stars.

On Holism Ark there were sim rooms of Earth. This little world, Rodi decided, was like a folded-up bit of Earth. They swept over oceans that sparkled in the jostling starlight -- and then flew into an impossible dawn.

It was impossible because there was no sun.

"It doesn't make sense," Thet murmured. The light was diffusing down from a glowing sky. "Where's that damn sunlight coming from?... And the planet's only a quarter Earth's size, gravity a sixth standard -- too low for this thick layer of air..."

Rodi smiled. The little world was like a toy.

Thet poked buttons in triumph. "Contact! About time..."

A Virtual tank filled up with a smiling male face, long and gracefully austere. He spoke; Rodi picked out maybe one word in two. After a few seconds he flicked the translator button mounted in his thumbnail.

"...this equipment's a little dusty, I'm afraid; we don't get too many visitors. It's only chance I was in the museum when the alarm chimed--"

"We represent the Exaltation of the Integrality," said Thet formally. "We come from beyond the stars. We are human like yourselves."

The man laughed; his eyes' folds crinkled. "Thank you, my dear. You're welcome to land and talk to us. But you'll find we're quite sophisticated. Use this signal as a beacon. The name of this area is Tycho..."

Thet let Rodi pilot the flitter out of orbit. Fifty miles above the surface the little craft shuddered; Rodi's palms

grew slick with sweat.

"That wasn't your fault, surprisingly," Thet said calmly. "We just passed through a kind of membrane. It's -- healing -- behind us. Now we know how they keep the atmosphere in. And maybe this is where the sunshine comes from. Interesting."

The Tycho museum perched at the summit of a green-clad mountain. A tall figure waved. The mountain was at the center of a plain which glistened with lakes and trees. The plain was walled by a circle of jagged hills. As they descended the hills dipped over the horizon.

Rodi landed neatly.

The air carried the scent of pine. Through the day-lit membrane Rodi could see stars; towards the horizon they were stained blue. He breathed deeply, invigorated.

Thet whooped. "I love this dinky gravity." She did a neat double back somersault, her long legs flexing.

Their host walked around the curve of the little museum. He wore a white coverall and he was at least eight feet tall. He smiled. "Welcome," he said. "My name is Darby."

Thet landed breathlessly and introduced herself and Rodi. "Come to my home," said Darby. "My family will be more than excited to meet you. And you can tell us all about your... integrality."

Rodi looked around for a transport. There was none.

Darby said nothing. He held out his hands. Like children, Rodi and Thet took hold.

Rodi saw Darby's coverall ripple, as if in a sudden breeze.

The museum, the flitter slid away.

Rodi looked down. He was flying, as if in a glass elevator. He felt no fear. Hand in hand they soared over the curves of the little world.

Darby's home was a tentlike, translucent structure; it was at the heart of a light-filled forest. The days were as

long as Ark days, adhering to some ancient, common standard. Thet and Rodi spent four days with Darby's family.

Thet looked out of place in all this domesticity: squat, brusque, embarrassed by kindness. She let Rodi talk to the adults while she sat on the leaf-strewn ground telling Integrality parables to Darby's two children. Each child towered over Thet. Their earnestness made Rodi smile.

On the final day Darby took Rodi by the hand. "Come with me. I'd like to show you a little more of our world."

They flew soundlessly. Houseboats floated on circular oceans; clumps of dwellings grew by the banks of rivers. Everywhere people waved at them. "This is a peaceful place, you see, Rodi," Darby said. "There are only a few thousand of us."

"Yes. And this orderly world has risen from the debris of war... just as the Integrality teaches us to expect. As I've told you, the Integrality is a movement based on the inter-meshing of all things. Local reductions in entropy occur on all scales throughout the Universe, from the growth of a child to the convergence of a galaxy cluster. Order is to be celebrated..."

Irritation touched Darby's face briefly. He said nothing. Rodi fell silent, faintly embarrassed.

At a savannah's heart sat a simple dome. "This is a place we call Tranquility," said Darby. "What I'm going to show you is a kind of monument. On seeing this perhaps you'll understand why your sermons are a little out of place here."

They landed like leaves.

Rodi peered through the clear dome wall. Boulders littered a patch of bald earth. There was a craft, a spiderlike structure as tall as a man. Gold foil gleamed through years of dust. Its colors faded beyond recognition, a flag lay in the soil.

"Here is the original surface of the planet, preserved through the terraforming," said Darby. "Airless."

"The craft looks very old. What is it?"

"Human, of course. This is one of our first spacecraft. Do you know where you are yet?"

Rodi turned and met Darby's mild eyes.

"This is the Moon," Darby said. "The original satellite of Earth. It was used in some ancient assault on the Ring... abandoned here, millions of light years from home, and terraformed by the handful of survivors." He smiled. "Rodi, every glance at the night sky tells us where we are and how we got here. We live surrounded by the rubble of the past, the foolish sacrifices of war."

"We have had to come to terms with this, you see. We have made our peace with the Universe. Perhaps your Integrality has something to learn from us."

Rodi stared for long minutes at the ancient craft. Then Darby took his arm. "I'll take you back to your flitter. Your companion is already waiting for you."

Hand in hand, they flew to the grass-coated walls of Tycho Crater.

The flitter soared through hyperspace.

"Those damn kids taught me a song," Thet said. She recited: "*We may with more successful hope resolve / To wage by force or guile eternal war / Irreconcilable to our grand Foe...*" That's all there was."

Rodi frowned. "Strange sort of kids' song."

"Sounds very old, doesn't it? The kids say they learn it from older children, and so it's passed on." Punching the controls briskly, she said, "Well, that's your first drop. Wasn't so bad, was it? Next one solo, maybe."

Sunk in depression, Rodi tapped at the data desk built into his thumbnail. "What do you know about glotto-chronology?"

Thet snorted. "What do you think?"

"It's one of our standard dating mechanisms. Starting from a common root, the languages of two human groups will diverge by a fifth every thousand years." Tiny numbers flickered over his nail. "About half of Darby's vocabulary is close to ours. That makes the colony about three thousand years old... This war has endured for millennia."

"We know that." Thet's brow furrowed as she concentrated on her piloting. "This is actually a bit tricky. The inseparability net is breaking up a little; the guidance beacons are flickering... there are ripples in hyperspace; large mass movements somewhere. A quake on a nearby neutron star?"

Rodi found himself blurting, "Is it always like that?"

"What?"

"Darby..."

"What did you expect? To convert him?"

Rodi thought it over. "Yes."

She laughed at that. She was still laughing as they passed into the warm interior of the Ark.

Holism Ark was a sphere miles wide. Its human fabric was sustained from huge chambers strung around the equator, where the Ark's spin gave the illusion of gravity. There were industrial zones, biotech tanks, sim rooms, health and exercise facilities. The weightless axis was a tunnel glowing with light. Tiled corridors branched away to riddle the Ark.

The flitter docked at a pole. Rodi slipped his arms into a set of light wings and swam along the axis. He was due to meet his seminary tutor, Gren, to discuss his voyage, and he tried to lift his mood. He stared around at the bustling life of the Ark: people coasting to and from work, children fluttering stubby wings in some complex game. Rodi felt isolated from it all, as if his senses were clouded by his depression.



There was a free fall common room at the center of the Ark. Gren met him there, tethered to a floating table. Gren was a round, comfortable man. Over a coffee globe he congratulated Rodi. "I was interested by that bit of doggerel Thet picked up," he said. "Did you know we've found similar fragments before?"

"Really?" Rodi hung up his wings and fiddled with his table tether.

"Strange, isn't it? These scattered bits of humanity slavishly maintaining their scraps of verse. We've a data store full of them... But what's it all for?" Gren put on a look of comic puzzlement.

Rodi drew a coffee globe from the table's dispenser. "Gren, why are the Ark's corridors tiled?"

Gren sipped his drink and eyed Rodi. He said carefully, "Because it's more comfortable that way."

"For us, yes. But this Ark is a Spline ship. How must the Spline feel? Once the Spline were free traders. Now we've sanitized this being's guts and built controls into its consciousness. Gren, we preach the wholeness of life, the growth to completeness. Is that a suitable way to treat a fellow creature?"

"Ah. Your first drop didn't turn out as you expected." He smiled. "You're not the first to react like this."

Rodi cradled the coffee globe's warmth close to his chest. "Please take me seriously, Gren. Is our philosophy, this great crusade to the Ring, a sham?"

"You know it isn't. The Integrality is a movement based on centuries of hard human experience. It has quasi-religious elements. Even the words we use -- 'seminary,' 'mission' -- have the scent of ancient faiths. That's no sham; it's quite deliberate. We want the Integrality to be vibrant enough to replace other faiths... especially man's dark passion to die on a mass scale."

"War--"

Gren thumped the table, his round face absurdly serious. "Yes, war. And that's why the resources of planets were spent to send the Exaltation here, to the site of man's greatest and most futile war.

"Rodi, come to terms with your doubts. Humanity is *large*: scattered, diverse. You found the Moon people discouraging. Well, they have found their own peace. That is not a threat to the validity of our crusade."

Another table drifted by. A young couple whispered into each other's mouths. Rodi watched them absently, thinking of his parents. Both of them worked in the Ark's biotech tanks. He recalled their pride when he was selected for the seminary, and then for the missionary cohort...

Gren was smiling again. "Anyway, you haven't long to brood before you go out again."

Rodi looked up, startled. "You still think I'm suitable?"

"Of course. Do we want ignorant fanatics? We want young people who can *think*, boy.

"Now. There's a neutron star, not far from here. Spinning very fast... we've picked up a signal from its surface."

Rodi stared. "A human signal?"

Gren laughed kindly. "Well, of course a human signal. Why else would we send you?"

Rodi finished his drink and pushed the globe back into the table. "I guess I'd better find Thet..."

Gren laid a warm hand on his arm. "Rodi, this time you're on your own. Go and get some sleep; you've a few hours to spare--"

The flitter seemed empty without Thet.

The Spline's orifice dilated and Rodi returned to hyperspace. He began to thread his way out of the Exaltation, keeping his breath carefully level.

A Virtual sparkled into existence; Thet grinned. "Going solo this time, kid? I just called to wish you luck." Rodi

thanked her. "Listen, Rodi... don't let me get you down. I rag everybody, and my opinions are my own. Right? And you did okay, down there on the Moon. Be safe." She winked at him and the Virtual dissipated.

Feeling warmer, Rodi dropped into three-space.

The neutron star was one of a binary pair. It was the remnant of a blue-white giant, once so bright it must have made its companion star cast a shadow. Perhaps there had been planets.

The giant had exploded.

Planets evaporated like dew and layers of the companion star blasted away. The giant's remnant collapsed into a wizened, spinning cinder as massive as Earth's sun but barely ten miles across.

The new neutron star dragged down material from its companion and rotated ever faster. The spin deformed it until at last it was virtually a disc, its rim moving at a third the speed of light. Spin effects there canceled out the star's ferocious gravity and a layer of normal matter began to accrete...

A human ship had blundered here, scarred by some forgotten war; Rodi found a battered wreck in close orbit around the neutron star. The crew had no way back to hyperspace and no way to call for help.

And in this dismal system there had been only one place that could conceivably sustain human life...

In Rodi's monitors the neutron star was a plate of red-hot charcoal. A point on the rim was emitting green laser light, picking out a message in something called Morse code. The message was one word of ancient English. "Mayday. Mayday..."

Rodi set up a reply, in the same old tongue and code. "I represent the Exaltation of the Integrality. What is *mayday*?"

The reply came a day later.

"Apologies are offered for the delay. It took time to locate the Comms Officer. I am the Comms Officer. What do you want?"

"My name is Rodi. I have traveled here in an Exaltation of Arks. I have brought you good news of the Integrality--"

"Are you human?"

"Yes, of course. How long have you been stranded?"

"Stranded where?"

Rodi pulled at his chin. "Would you like to hear of events in the galaxies? Of the wars with the Xeelee?"

"What are galaxies? -- Cancel question. Please understand that this is the first time the Comms System has evoked a reply--"

"Then why have you maintained it?"

"Because we always have. The role of Comms Officer is handed from mother to daughter. We know we came from somewhere else. The Comms System is the only link with this other place, our origin. How could we abandon it? Are you in this other place?"

"Yes. You are not alone."

"How reassuring."

Rodi raised an eyebrow. Sarcasm? "Please describe your world."

"What world?"

It took some time to achieve a common understanding.

The stranded crew had observed the layer of soupy liquid at the star rim. The liquid was full of complex molecules, left over from the supernova's fusion fury.

It was their only hope.

With astonishing audacity they had terraformed the ring-shaped sea. Then they began to mold their own unborn children.

Their descendants swam like fish in a dull red toroidal ocean, chattering English. They didn't need hands or tools; only the old Comms System had been left for them, lasing

its message to the skies. Rodi imagined the Comms Officer tapping a broad, unwearing key with his mouth or tongue.

Rodi sent down a small, sturdy probe. It was a passing novelty among the fish-folk. Rodi wondered if they thought he was swimming somewhere inside.

There was a death among the fish-folk. A corpse fell from a school of wailing relatives and settled slowly to the star's glowing surface.

Rodi's probe took a tissue sample from the corpse.

The fish-folk were beyond the reach of the glotto-chronology dating technique. Rodi turned to genetic analysis. Two groups on Earth will show divergence of genetic structure at a rate of one percent every five million years.

Rodi found that the fish-folk had swum their ocean for fifty thousand years.

That appalled him. How long had this damn Xeelee war dragged on? How many human lives had been wasted?

The fish-folk weren't too impressed by the Integrality.

"All mankind is joined in freedom," said Rodi. "The worlds in home space are joined by inseparability links into a neural network; decisions flow through the net and reflect the wills of all, not just one person or one group..."

And so on.

The Comms Officer was silent for a long time. Then: "What you say means little to us."

"Your world is unchanging. You are isolated. You are cut out of the great events which shape the greater human history."

"But great events mark our lives," said the Comms Officer, and Rodi wondered if he had given offense. "Our convocations, for instance. There are places where we swim in concert and cause the ocean to sing. We did this not long ago."

That puzzled Rodi. It sounded like a starquake, a sudden collapse of the crust; that would make the whole star ring

like a bell.

Could they cause a starquake?

Perhaps they had some way of manipulating the star's ferocious magnetic field. And after all, a quake had disrupted the Exaltation inseparability net not long ago.

After a fortnight Rodi took his leave of his friend.

"Wait," the Comms Officer said unexpectedly. "I have a message to give you." And he transmitted: "*Our grand Foe, / Who now triumphs, and in the excess of joy / Sole reigning holds the tyranny of heaven.*"

"What does it mean?" asked Rodi.

"Unknown."

"Then why do you send it?"

"Every Comms Officer is taught to send it."

"Why?"

"What is 'heaven'?"

"Unknown."

Rodi thought of the rhyme the Moon children had taught Thet. *To wage by force or guile eternal war / Irreconcilable to our grand Foe, / Who now triumphs, and in the excess of joy...*

The pieces fit together, he realized, astonished.

He transmitted his conclusion to Holism Ark for analysis.

Rodi went through the motions of lifting the flutter back to hyperspace, his thoughts clouded.

Once more his mission hadn't unfolded as he'd been taught to expect.

The humans in this region had been forced to find their own ways to come to terms with the events that had stranded them. If they hadn't they couldn't have survived. So -- why did they need the Integrality? -- or a junior missionary like himself?

Was the Integrality's crusade meaningless?...

The Exaltation's formation had changed.

His speculations driven from his mind, he stared at his monitors. Around Holism Ark the fleet's symmetrical pattern had been distorted into a wedge; at the tip the Arks' fleshy walls were almost touching. Flitters scurried between the Arks; hundreds of closed-beam inseparability net messages radiated away from Holism Ark.

What was happening?

He pushed into Holism Ark. The maintenance bay was deserted. He flew through an axis filled with a harsh light. People rushed past, wings fluttering.

Men and women came along the axis shoving a cannon-like piece of equipment. Rodi recognized a machine-shop heavy-duty laser. He had to press against the wall to allow the team to pass. Their eyes passed blankly over him.

Rodi noticed a fist-sized, fleshy lump on the back of the neck of the nearest man, at the top of his spine.

The freefall common room was unrecognizable. Rodi clung to a wall and stared around. The floating tables were being cleared away; he saw a group of children shooed through the commotion.

There were more bulges on the spinal columns of the crew. Even the children were affected. Some sort of sickness?

A hundred crewmen worked to bolt together a huge, cubical lattice. Eventually, Rodi realized, it would fill the common room. Medical devices and supplies were strapped to struts. Rough hands pushed a man-sized bundle of blankets into the lattice. Then another, and a third...

Crew members in sterile masks unwrapped the bundles.

Suddenly Rodi saw it.

This was a hospital. It was being built in the soft heart of the Ark -- the most protected place in case of attack. And towards the hull they were taking heavy-duty lasers -- to use as weapons?

Holism Ark was preparing for war.

Rodi's head pounded and there was a metallic taste at the back of his throat.

Thet came sweeping across the bustling space, towing a small package of clothes.

Rodi pushed away from the wall and grabbed her arm.

"The philosopher returns," Thet said, grinning. Her eyes sparkled and her face was flushed.

There was a growth at the top of her spine.

"Thet... what's happening?"

"I'm going to Unity Ark. As a Battle Captain. Isn't it fantastic?"

"Battle? Against who?"

"The Xeelee. Who else? Why do you think we came all this way?"

Rodi tightened his grip on her upper arm. "We came for the Integrality. Remember? We came to remove war, not to wage it."

She laughed in his face, her mouth wide. "That's yesterday, Rodi. It's all gone. And you know who we have to thank? You. Isn't that ironic?" With fingers like steel she prised open his hand and kicked away.

"Where's Gren?"

"In the sanatorium," she called back. "And, Rodi... that's your fault too."

Rodi hung there for long minutes. Then he turned to the makeshift hospital.

Gren lay in a honeycomb of suffering people. Bandaging swathed his neck.

Rodi touched the shrunken face. Gren's eyes flickered open. His face creased as he recognized Rodi. He whispered: "*...our grand Foe, / Who now triumphs, and in the excess of joy / Sole reigning holds the tyranny of heaven!*" He grimaced. "You have to admire the planning. Over thousands of centuries, even as humans died before



the Xeelee, they hid those words among thousands of fragments of verse, and built an epic deception..."

"Please," Rodi said miserably, "I don't understand any of this."

Gren stirred. "I'm sorry, Rodi. The truth is that the Integrality is a fraud, an epic deception spanning millennia. Our mission was a lie which has allowed this huge armada to penetrate Xeelee space, its true purpose unknown even to generations of crew.

"The reassembled poetry was the key, you see. Hearing those words ignited something in each of us -- something locked in the genetic code that defines us. We began to suffer explosive growths--"

Rodi fingered his own smooth neck.

"You're a lucky one," Gren whispered. "It doesn't always work. A tenth of us are unaffected. Perhaps two-thirds have been -- programed. Like Thet. And the rest of us are dying."

Rodi turned away.

Gren said, "No, Rodi. Hear the rest. The growths are nervous tissue. They contain information... it's like a false memory. And an obsession. I walked to a wall and touched tiles in a certain way; control panels unfolded -- and I knew how to work weapons mounted in the hull... The Exaltation is a deception, the message of the Integrality a way to enable a war fleet to approach the Ring.

"Your poetry is being spread from Holism by closed inseparability net. Not all the Exaltation has yet been infected. But... but finally..." His rheumy eyes fluttered closed.

Rodi shook frail shoulders. "Gren... tell me what to do. We've got to stop this--"

Gren's mouth gaped, spittle looping between his lips.

Holism Ark had become an alien place. Rodi watched weapons pods erupting from walls still coated with uplifting Integrality slogans.

He thought of trying to find his parents. He envisaged their grisly welcome, overlaid with spinal knots and blank, driven faces.

He shuddered and swam towards the flitter hangars. There was no way he could influence events here. Perhaps if he made his way to the battle site...

Then what?

He readied the flitter for launch, trying to lose himself in activity.

He skimmed the surface of the Ark; the blisters which had puzzled him earlier had now opened up to reveal the snouts of weapons and guidance sensors.

He pulled away. Much of the Exaltation, he saw, was still unaffected and held its formation. He flew to the tip of the flying wedge.

For the first time in three thousand years, the great Arks were leaving hyperspace.

His heart heavy, he swept ahead of the fleet and dropped into three-space.

He was in a mist of blue-stained stars. A torus glowed: Bolder's Ring, still hundreds of light years away but already spanning the sky.

He pushed towards the Ring.

The flitter passed through the last veil of crushed matter and entered the clear space at the bottom of the Ring's gravity well... and for a few seconds, despite everything, Rodi's breath grew short with wonder.

The Ring, a tangle of cosmic string, glittered as it rotated. There was a milky place at its very center, a hole ripped in the fabric of space by that monstrous, whirling mass.

Xeelee were everywhere.

Ships miles wide swept over the artifact's sparkling planes, endlessly constructing and shaping. Rodi watched a horde of craft using cherry-red beams to herd a star, an orange giant, into a soft, slow collision with the Ring. The

star's structure was breaking up as cosmic string ripped into its flank--

A dozen flesh-pale spheres hurtled over Rodi's head, spitting fire.

They were Spline: the warships of the Integrality. They tore towards the star drovers and battle was joined.

At first the humans had the advantage of surprise. The ponderous Xeelee construction ships scattered in confusion. One of them was caught in the cross-fire of two Arks; Rodi could see its structure melt and smolder. More human ships dropped out of hyperspace and the battle spread.

But now a Spline ship splashed open. Rodi watched people wriggle in vacuum, soaked by spurts of Spline blood.

A Xeelee nightfighter covered the wreck with wings a hundred miles wide.

There were nightfighters all around the battle site. Fire bit into the sides of the laboring Spline.

It was a massacre.

Rodi could not bear to watch. Each Ark was a world, millennia old, carrying families... He increased the scale of his monitors, turned the battle into a game of toys.

But now the Xeelee fighters pulled away. They folded their wings and hovered outside the mist of debris, almost aloof.

The human ships tore into the defenseless construction vessels. Out of control, the orange star splashed against the Ring surface.

The Arks withdrew to hyperspace. One of them whirled as if in jubilation, spitting fire in all directions. Wrecks sailed into clumsy orbits around the Ring.

The Xeelee fighters departed, wings shimmering.

Rodi closed his eyes.

This had been no triumph for the humans. The Xeelee had given them a meaningless victory; they had simply not

wished to slaughter.

Couldn't the human crews see that? Would this happen again and again until every Ark was disabled, every human life lost?

No. He couldn't let it occur. And, he began to realize, there was a way he could prevent it.

He opened his eyes, rubbed his face, and lifted the flitter to hyperspace.

The neutron star scraped the surface of its companion, just as it had in that dream time before the metamorphosis. "Integrity for the Comms Officer--"

"Greetings, Rodi from the Integrity."

Rodi, in broken bits of old English, described the futile battle.

The Comms Officer mulled it over. "I understand little... only that people are dying for a foolish purpose."

"But with your help, I can avert many deaths."

"How?"

"Not all the Exaltation has been... contaminated. The virus of words is spreading via inseparability net links. If we break those links, the spread will stop."

"And how can we disrupt this inseparability net?"

"Cause a starquake."

He had to expand, to explain what he meant.

The Comms Officer hesitated. "Rodi, there are two things you should know. We cause these events for specific religious and sexual reasons. They are not -- a sport. Second, many of us will lose our lives."

"I know what I'm asking."

A monitor flashed: another craft had dropped out of hyperspace near him. A Virtual tank filled up with a grinning face.

The craft was Unity Ark. The face was Thet's.

She said, "They told me your flitter was gone. It wasn't hard to work out where you'd be. You're planning sabotage,

aren't you?"

Rodi stared at her.

"Are we still in contact, Rodi of the Integrality?"

"Yes, Comms Officer..."

"Rodi, you have one minute to begin your approach to Unity. After that we open fire. Do you understand?"

"Comms Officer, what is your answer?"

"I must consult."

"Please hurry. I am desperate."

Thet's smile broadened as the minute passed. Rodi realized that the metamorphosis was a liberation for her; she made a much better warrior than missionary.

"Time's up, Rodi."

"Integrality? We will do as you say."

"Thank you!"

And Rodi slammed the flitter into hyperspace; Thet snarled.

The Exaltation was beginning to split up.

The Arks, the metamorphosed battleships, continued to drop into three-space... but they returned battered and bleeding, and there were fewer each time.

The bulk of the fleet, now isolated from infection, cruised on its way.

Rodi probed at his feelings. Had he betrayed his race by wrecking this grand design?

But the stratagem itself had been a betrayal -- of the generations who had lived and died in the Exaltation, and, yes, of the ideal of the Integrality itself.

He wondered if Gren's hypothesis, of a key embedded in fragments of poetry, could hold truth. It seemed fantastic... and yet the fragments of verse had indeed been laid there, like a trail. Perhaps there were a dozen keys, scattered across the light years and centuries, reinforcing each other -- some perhaps even embedded in the structure of the space through which the Exaltation must pass.

Or perhaps, Rodi thought bleakly, no key was necessary. He thought of Thet. She, in retrospect, had been all too willing to throw over the ideals of the Integrality, and indulge in warfare once more -- key or no key.

But the perpetrators of this epochal plot had been too clever. In their search for a fine lie they had stumbled on a truth -- the truth at the heart of the Integrality's philosophy -- and that truth, Rodi realized, was driving him to act as he did.

And so in the end it was the truth which had betrayed them.

Rodi would never see his parents again.

But the Exaltation would go on. He could join another Ark, and--

Thet's voice hissed through the distorted inseparability net. "I know... you've done..."

Unity Ark loomed in his monitors, its bulk cutting him off from the Exaltation.

"Thet. There's no point--"

The flitter slammed.

"...next time..."

Roaring with frustration he dropped into three-space, emerging poised over the Ring.

Unity Ark closed, bristling with weapons. Thet's image was clear. "It's over, Rodi."

Rodi took his hands from the controls. He felt very tired. "Okay, Thet. You're right. It's over. We're both cut off from the Exaltation. We're stranded here. Kill me if you like."

Unity Ark exploded at him. Thet stared into his eyes.

Then she cried out, as if in pain.

The Ark veered sideways, avoiding Rodi, and disappeared into the mist at the heart of the Ring.

"Integrality calling Comms Officer."

"This is the Comms Officer."

"How are you?"

"I am not the one who spoke to you previously. My mother died in the recent convocation."

"...I'm sorry."

"Did we succeed?"

In simple terms, Rodi told the story.

"So, in the end, Thet spared you. Why?"

"I don't know. Perhaps the futility of it all got through to her. Perhaps she realized that with all contact with the Exaltation lost her best chance of survival was to take the Ark away, try for a new beginning in some fresh Universe..." And perhaps some lingering human feeling had in the end triumphed over the programing.

"But now you are stranded, Rodi. You have lost your family."

"...Yes."

"You are welcome here. You could join my sexual grouping. The surgery required is superficial--"

Rodi laughed. "Thank you. But that's well beyond my resources."

"What, then?"

He remembered Darby's wise kindness. If the Lunar colonists welcomed him, perhaps the loss of his family would grow less painful...

"We will remember you, and your Integrality."

"Thank you, Comms Officer."

Rodi turned the battered flitter and set course for the Moon.

*Fragments of humanity. Relics of forgotten battles, aborted assaults...*

*Here was the most extravagant mission of all.*

*Once the system had been a spectacular binary pair, adorning some galaxy lost in the sky. Then one of the stars had suffered a supernova explosion, briefly and gloriously outshining its parent galaxy. The explosion had destroyed*

*any planets, and damaged the companion star. After that, the remnant neutron star slowly cooled, glitching as it spun like some giant stirring in its sleep, while its companion star shed its life-blood hydrogen fuel over the neutron star's wizened flesh. Slowly, a ring of companion-gas formed around the neutron star, and the system's strange, spectral second system of planets coalesced.*

*Then human beings had come here.*

*The humans soared about the system, surveying. They settled on the largest planet in the smoke ring. They threw microscopic wormhole mouths into the cooling corpse of the neutron star, and down through the wormholes they poured devices and human-analogues, made robust enough to survive in the neutron star's impossibly rigorous environment.*

*The devices and human-analogues had been tiny, like finely jeweled toys.*

*The human-analogues and their devices swarmed to a magnetic pole of the neutron star, and great machines were erected there: discontinuity drives, perhaps powered by the immense energy reserves of the neutron star itself.*

*Slowly at first, then with increasing acceleration, the neutron star -- dragging its attendant companion, ring and planets with it -- was forced out of its parent galaxy and thrown across space, a bullet of stellar mass fired at almost light speed.*

*"A bullet," I said. "Yes. An apt term."*

*A bullet directed at the heart of the Xeelee Project.*

*"But," Eve said, "when the single, immense shot had been fired, little thought was given to those abandoned within the star, their usefulness over..."[\[6\]](#)*



# Hero

**A.D. 193,474**

When Thea wore the Hero's suit, Waving became *extraordinary*.

Breathless, she swept from the leafy fringe of the Crust forest and down, down through the Mantle's vortex lines, until it seemed she could plunge deep into the bruised-purple heart of the Quantum Sea itself!

Was this how life had been, before the Core Wars? Oh, how she wished she had been born into the era of her grandparents -- before the Wars -- instead of these dreary, starving times.

She turned her face towards the South Pole, that place where all the vortex lines converged in a pink, misty infinity. She surged on through the Air, drowning her wistfulness and doubt in motion...

But there was something in the way.

Everyone had heard of the Hero, of course. The Hero myth was somehow more vivid to Thea than, say, the legends of the Ur-humans, who (it was said) had come from beyond the Star to build people to live here in the Mantle -- and who then, after the Core Wars, had abandoned them. Perhaps it was because the Hero was of her own world, not of some misty, remote past.

Even as she grew older -- and she came to understand how dull and without prospect her parents' world really was -- Thea longed for the Hero, in his suit of silver, to come floating up through the sky to take her away from the

endless, drudging poverty of this life of hunting and scavenging at the fringe of the Crust forest.

But by the time she reached the age of fifteen she'd come to doubt that the Hero really existed: in the struggle to survive amid the endless debris of the Core Wars, the Hero was just too convenient a wish-fulfilling myth to be credible.

She certainly never expected to *meet* him.

"Thea! *Thea!*"

Snug inside her cocoon of woven spin-spider webbing, Thea kept her eyecups clamped closed. Her sister, Lur, was eighteen -- three years older than Thea -- and yet, Thea thought sourly, she still had the thin, grating tones of an adolescent. Just like a kid, especially when she was scared--

*Scared.*

The thought jolted Thea awake. She struggled to free her arms of the cocoon's clinging webbing, and pushed her face out into the cool Air. She shook her head to clear clouded Air out of her sleep-rimmed eyecups.

Thea cast brisk, efficient glances around the treacherous sky. Lur was still calling her name. Danger was approaching, then. But from where?

Thea's world was the Mantle of the Star, an immense cavern of yellow-white Air bounded above by the Crust and below by the Quantum Sea. The Crust itself was a rich, matted ceiling, purple-streaked with krypton grass and the graceful curves of tree trunks. Far below Thea, the Sea formed a floor to the world, mist-shrouded and indistinct. All around her, filling the Air between Crust and Sea, the vortex lines were an electric-blue cage. The lines filled space in a hexagonal array spaced about ten mansheights apart; they swept around the Star from the far upflux -- the North -- and arced past her like the trajectories of immense, graceful animals, converging at last into the soft

red blur that was the South Pole, millions of mansheights away.

Thea's people lived at the lower, leafy fringe of the Crust forest. Their cocoons were suspended from the trees' outer branches, soft forms among the shiny, neutrino-opaque leaves; and as the humans emerged they looked -- Thea thought with a contempt that surprised her -- like bizarre animals: metamorphosing creatures of the forest, not human at all. But the cries of children, the frightened, angry shouts of adults, were far *too* human... The tribe's small herd of Air-pigs, too, were squealing in unison, thrashing inside the loose net that bound them together, and staining the Air green with their jetfarts.

But where was the danger?

She held her fingers up before her face, trying to judge the spacing and pattern of the vortex lines. Were they drifting, becoming unstable?

Twice already in Thea's short life, the Star had been struck by Glitches -- starquakes. During a Glitch, the vortex lines would come sliding up through the Air, infinite and deadly, scything through the soft matter of the Crust forest -- and humans, and their belongings -- as if they were no more substantial than spoiled Air-pig meat...

But today the lines of quantized spin looked stable: only the regular cycles of bunching which humans used to count their time marred the lines' stately progress.

Then what? A spin-spider, perhaps? But spiders lived in the open Air, building their webs across the vortex lines; they wouldn't venture into the forest.

She saw Lur, now; her sister was trying to Wave towards her, obviously panicking, her limbs uncoordinated, thrashing at the Magfield. Lur was pointing past Thea, still shouting something--

There was a breath of Air at Thea's back. A faint shadow.

She shifted her head to the right, feeling the lip of her cocoon scratch her bare skin.

A ray, no more than two mansheights away, slid softly towards her.

Thea froze. Rays were among the forest's deadliest predators. She couldn't possibly get out of the cocoon and away in time -- her only hope was to stay still and pray that the ray didn't notice she was here...

The ray was a translucent cloud a mansheight across. It was built around a thin, cylindrical spine, and six tiny, spherical eyes ringed the babyish maw set into its sketch of a face. The fins were six wide, thin sheets spaced evenly around the body; the fins rippled as the ray moved, electron gas sparkling around their leading edges. The flesh was almost transparent, and Thea could see shadowy fragments of some meal passing along the ray's cylindrical gut.

The ray came within a mansheight of her. It slowed. She held her breath and willed her limbs into stillness.

*I might live through this yet...*

Then -- with ghastly, heart-stopping slowness -- the ray swiveled its hexagon of eyes towards her, unmistakably locking onto her face.

She closed her eyes. Perhaps if she didn't struggle it would be quicker...

Then, *he came*.

There was a blue-white flash: a pillar of electron light that penetrated even her closed eyecups, and ripped through the encroaching silver-gray shadow of the ray.

She cried out. It was the first sound she had made since waking into this nightmare, she realized dully.

She opened her eyes. The ray had pulled away from her and was twisting in the air. *The ray was being attacked*, she saw, disbelieving: a bolt of electron light swept down through the Air and slanted into the ray's misty structure, leaving the broad fins in crudely torn shreds. The ray

emitted a high, thin keening; it tried to twist its head around to tear into this light-demon--

No, Thea saw now; this was no bolt of light, no demon: this was a *man*, a man who had wrapped his arms around the thin torso of the ray and was squeezing it, crushing the life out of the creature even as she watched.

She hung in her cocoon, even her fear dissolving in wonder. It was a man, true, but like no man she'd seen before. Instead of ropes and ponchos of Air-pig leather, this stranger wore an enclosing suit of some supple, silver-black substance that crackled with electron gas as he moved. Even his head was enclosed, with a clear plate before his face. There was a blade -- a sword, of the same gleaming substance as the suit -- tucked into his belt.

The ray stopped struggling. Fragments of half-digested leaf matter spewed from its gaping mouth, and its eyestalks folded in towards the center of its face.

The man pushed the corpse away from him. For a moment his shoulders seemed to hunch, as if he were weary; with gloved hands he brushed at his suit, dislodging shreds of ray flesh which clung there.

Thea stared, still in her cocoon, unable to take her eyes from his shimmering movements.

Now the man turned to Thea. With a single, feathery beat of his legs he Waved to her. The suit was of some black material inlaid with silvery whirls and threads. Apart from a large seam down the front of the chest, the suit was an unbroken whole, complete like an spin-spider eggshell. Behind the half-reflective helmet plate she could see a face -- surprisingly thin, with two dark eyecups. When he spoke, his voice was harsh, but sounded as natural as if he were one of her own people.

"Are you all right? Are you hurt?"

Before Thea could answer Lur came Waving clumsily out of the sky, her small breasts shaking. Lur grabbed at Thea's

cocoon and clung to it, burying her face in Thea's neck, sobbing.

Thea saw the stranger's shadowed gaze slice over Lur's body with analytical interest.

Thea encompassed Lur's shoulders in her arms. She kept her eyes fixed on the man's face. "Are you *real*? I mean -- are you *him*? The Hero?"

Was it *possible*?

He looked at her and smiled obscurely, his face indistinct in the shadows of his suit.

She tried to analyze her feelings. As a child, when she'd envisaged this impossible moment -- of the actual arrival of the Hero, from out of nowhere to help her -- she'd always imagined a feeling of *safety*: that she would be able to immerse herself in the Hero's massive, comforting presence.

But it wasn't like that. With his face half-masked the Hero wasn't comforting at all. In fact he seemed barely human, she realized.

Behind the translucent pane, the Hero's eyes returned to Lur, calculating.

Her father wept.

Wesa's thin, tired face, under its thatch of prematurely yellowed hair-tubes, was twisted with anguish. "I couldn't reach you. I could see what was happening, but--"

Embarrassed, she submitted to his embrace. Wesa's thin voice, with its words of self-justification, had less to do with her safety than with working out his own shock and shame, she realized.

As soon as she could, she got away from her father's clinging grasp.

Her people were clustered around the Hero.

The Hero ran a gloved thumb down the seam set in the suit's chest panel; the suit opened. He peeled it off whole, as if he were shedding a layer of skin. Under the suit he

wore only gray undershorts, and his skin was quite sallow. He was much thinner than he'd seemed inside the suit, although his muscles were hard knots.

Thea felt repelled. *Just a man, then. Is that all there is to it?* And an *old* man, too, with yellowed hair-tubes and sunken, wrinkled face -- older than anyone in her tribe, she realized.

He passed the suit to Wesa. Thea's father took the ungainly thing and tied it carefully to a tree branch. Suspended there, its empty limbs dangling and its chest sunken and billowing, the suit looked still more grotesque and menacing -- like a boned man, she thought.

Wesa -- and Lur, and some of the others -- clustered around the Hero again, bringing him food. Some of their prime food, too, the most recent of the Air-pig cuts.

The Hero crammed the food into his wizened mouth, grinning.

Later, the Hero donned his suit and went up into the forest, towards the root ceiling, alone. When he returned, he dragged a huge Air-pig after him.

The people -- Lur and Wesa among them -- clustered around again, patting at the fat Air-pig. The Air-pig's body was a rough cylinder; now, in its terror, its six eyestalks were fully extended, and its huge, basking maw was pursed up closed. Futile jetfarts clouded the Air around it.

It would have taken a team of men and women days to have a chance of returning with such a catch.

Even through his faceplate Thea could see the Hero's grin, as the people praised him.

She Waved away from the little encampment and perched in the thin outer branches of the forest. She snuggled against a branch, feeling the cold wood smooth against her skin, and nibbled at the young leaves which grew behind the wide, mature outer cups.

Then she curled into a ball against the branch, pushed more soft leaves into her mouth and tried to sleep.

A soft moan awoke her.

The smell of growing leaves was cloying in her nostrils. Blearily, she pushed her head out of the branches and into the Air.

There was motion far below her, silhouetted against the deep purple of the Quantum Sea. It was the Hero and her sister, Lur; they spiraled languidly around the vortex lines. The Hero wore his shining suit, but it was open to the waist. Lur had wrapped her legs around his hips. She arched away from him, her eyes closed. The Hero's skin looked *old*, corrupted, against Lur's flesh.

*Payment for the hunter...*

Thea ducked back into the forest and crammed her fists to her eyecups.

When she woke again, she felt depressed, listless.

She dropped out of the forest. She hovered in the Air, her knees tucked against her chest. With four or five brisk pushes she emptied her bowels. She watched the pale, odorless pellets of shit sail sparkling into the Air. Dense with neutrons, the waste would merge with the unbreathable underMantle and, perhaps, sink at last into the Quantum Sea.

The Hero was sleeping, tucked into a cocoon -- her *father's* cocoon, she realized with disgust. The empty suit was suspended from its branch. There seemed to be nobody about; most of the tribe were at the Air-pigs' net, evidently preparing one of the animals for slaughter.

Suddenly she felt awake -- alive, excited; capillaries opened across her face, tingling with superfluid Air. Silently, trying to hold her breath, she pushed herself away from her eyrie and Waved to the suit.



Its empty fingers and legs dangled before her, grisly but fascinating. She reached out a trembling hand. The fabric was finely worked, and the inlaid silver threads were smooth and cold.

The front of the suit gaped open. She pushed her hand inside; she found a soft, downy material that felt cool and comfortable...

It would be the work of a moment to slip her own legs into these black-silver leggings.

The Hero groaned, his lips parting softly; he turned slightly in her father's cocoon.

He was still asleep. Perhaps, Thea thought with disgust, he was dreaming of her sister.

She had to do this *now*.

Briskly, but with trembling fingers, she untied the suit from its branch. She twisted in the Air, tucked her knees to her chest and dropped her legs into the opened-up suit.

The lining sighed over her skin, embracing her flesh. She wriggled her arms into the sleeves. The feeling of the gloves around each finger was extraordinary; she stared at her hands, seeing how the tubes of fabric -- too long for her own fingers -- drooped slightly over her fingertips.

She pulled closed the chest panel and, as she'd seen the Hero do, ran her gloved thumb along the seam. It sealed smoothly. She reached back over her shoulders and pulled the helmet forward, letting it drop over her head. Again a simple swipe of the thumb was sufficient to seal the helmet against the rest of the suit.

The suit was too big for her; the lower rim of the faceplate was a dark line across her vision, cutting off half the world, and she could feel folds of loose material against her back and chest. But it encased her, just as it had the Hero, and -- when she raised her arms -- it moved as she moved.

Cautiously, experimentally, she tried to Wave. She arched her back and flexed her legs.

Electron gas crackled explosively around her limbs. She squirted clumsily across the tree-scape, branches and leaves battering at her skin.

She grabbed at the trees with her gloved hands, dragging herself to a halt.

She looked down at the suit, trembling afresh. It was as if the Magfield had picked her up and hurled her through the Air.

Such *power*.

She pushed down from the trees and out into the clear Air. She tried again -- but much more cautiously this time, with barely a flex of her legs. She jolted upwards through a few mansheights: still jarringly quickly, but this time under reasonable control.

She Waved again, moving in an awkward circle.

It ought to be simple enough to master, she told herself. After all, she was just *Waving*, as she had done from the moment she'd popped from her mother's womb. Waving meant dragging limbs -- which were electrically charged -- across the Magfield. The Star's powerful magnetic field induced electric currents in the limbs, which in turn pushed back at the Magfield.

Some part of this suit -- perhaps the silver-gleaming inlays -- must be a much better conductor than human flesh and bone. And so the Magfield's push was so much greater. It was just a question of getting the *feel* of it.

She leaned back against the Magfield and thrust gently with her legs. Gradually she learned to build up the tempo of this assisted Waving, and wisps of electron gas curled about her thighs. The secret was not strength, really, but gentleness, suppleness, a sensitivity to the soft resistance of the Magfield.

The suit carried her gracefully, effortlessly, across the flux lines.

She sailed across the sky. The suit felt natural about her body, as if it had always been there -- and she suspected that a small, inner part of her would always cling to the memory of this experience, utterly addicted...

The Hero's face ballooned up before her. She cried out. He grinned through the faceplate at her, the age-lines around his eyecups deep and shadowed. He grabbed her shoulders; she could feel his bony fingers dig into her flesh through the suit fabric.

"I came up under you," he said, his voice harsh. "I knew you couldn't see me. That damn helmet must be cutting off half your field of view."

Fright passed, and anger came to her. She raised her gloved hands and knocked his forearms away.

...*Easily*. He suppressed a cry and clutched his arms to his chest; rapidly he straightened up to face her, but not before she had seen the pain in his eyecups.

She reached out and grabbed the Hero's shoulders, as he'd held hers. In this suit, not only could she Wave like a god -- she was *strong*, stronger than she had ever imagined. She let her fingers dig into his bone. Laughing, she raised him above her head. He seemed to be trying to keep his face empty of expression; she saw little fear there, but there was something else: a *disquiet*.

"Who's the Hero now?" she spat.

"A suit of Corestuff doesn't make a hero."

"No," she said, thinking of Lur. "And heroes don't need to be *paid*..."

He grinned, mocking her.

She thought over what he'd said. "What's *Corestuff*?"

"Let me go and I'll tell you."

She hesitated.

He snapped, "Let me *go*, damn you. What do you think I can do to you?"

Cautiously she let go of his shoulders and pushed him away from her.

He rubbed at the bulging bones of his shoulders. "You may as well understand what you're stealing. *Corestuff*. The inlay in the fabric; a superconducting thread mined from within the Quantum Sea." He sniffed. "From the old days, before the Core Wars, of course."

"Did the suit belong to an Ur-human?"

He laughed sourly. "Ur-humans couldn't survive here inside the Mantle. Even a savage child should know that."

She looked carefully at his yellowed hair-tubes, unwilling to betray more ignorance. How old was he? "Do you remember the old days -- before the Core Wars? Is that how you got the suit?"

He looked at her with contempt -- but, he saw, a contempt softened with pity. *Am I really such a savage?* she wondered.

"Kid, the Wars were over before I was born. All the technology -- the cities, the wormhole paths across the Mantle -- all of it had gone. There were just a few scraps left -- like this suit, which my father salvaged." He grinned again, his face splitting like a skull. "It used to belong to police, in one of the great cities. *Police*. Do you know what that means?"

"The suit kept us alive -- my parents and me -- for a while. Then, after they were dead--"

She tried to fill her voice with contempt. "You used it to fly around the Mantle being the Hero."

He looked angry. "Is that so terrible? At least I *help* people. What will *you* do with it, little girl?"

She reached out for him, turning her hands into claws. In a moment, she could crush the life out of his bony neck--

He returned her stare calmly, unflinching.

She tipped backwards and Waved away from him.

Thea surged along infinite corridors of vortex lines. Floating spin-spider eggs padded at her faceplate and legs. The Quantum Sea was a purple floor far below her, delimiting the yellow Air; the Crust was a complex, inverted landscape beneath which she soared.

Waving was *glorious*. She stared down at her silver-coated body; blue highlights from the corridors of vortex lines and the soft purple glow of the Sea cast complex shadows across her chest. Already she was moving faster than she'd ever moved in her life, and she knew she was far from exhausting the possibilities of this magical suit.

She opened her mouth and yelled, her own voice loud inside the helmet.

She flew, spiraling, around the arcing vortex lines, her suited limbs crackling with blue electron gas; breathless, she swept from the leafy fringe of the Crust forest and down, down through the Mantle, until it seemed as if she could plunge deep into the bruised-purple heart of the Quantum Sea itself.

She turned her face towards the South Pole, that place where all the vortex lines converged. She surged on through the Air, drowning her doubts -- and the image of the Hero's disquieted face -- in motion.

...But there was something in her path.

*Spin-web.*

The web was fixed to the vortex line array by small, tight rings of webbing which encircled, without quite touching, the glowing spin-singularities. The web's threads were almost invisible individually, but the dense mats caught the yellow and purple glow of the Mantle, so that lines of light formed a complex tapestry.

It was really very beautiful, Thea thought abstractedly. But it was a wall across the sky.

The spin-spider itself was a dark mass in the upper corner of her vision. She wondered if it had already started moving towards the point where she would impact the net - or if it would wait until she was embedded in its sticky threads. The spider looked like an expanded, splayed-open version of an Air-pig. Each of its six legs was a mansheight long, and its open maw would be wide enough to enfold her torso.

Even the suit wouldn't protect her.

She swiveled her hips and beat at the Magfield with her legs, trying to shed her velocity. But she'd been going as rapidly as she could; she wouldn't be able to stop in time. She looked quickly around the sky. Perhaps she could divert rather than stop, fly safely around the trap. But she couldn't even *see* the edges of the web: spin-spider webs could be hundreds of mansheights across.

The web exploded out of the sky. She could *see* thick knots at the intersection of the threads, the glistening stickiness of the lines themselves.

She curled into a ball and tucked her suited arms over her head.

How could she have been so stupid as to fall into such a trap? Lur and Wesa, even through their tears, would think her a fool, when they heard. She imagined her father's voice: "Always look up- and downflux. Always. If you scare an Air-piglet, which way does it move? Along the flux paths, because it can move quickest that way. And that's why predators set their traps across the flux paths, waiting for anything stupid enough to fly straight into an open mouth..."

She wondered how long the spin-spider would take to clamber down to her. Would she still be conscious when it peeled open her Hero's suit as if unwrapping a leaf, and began its work on her body?

...A mass came hurtling from her peripheral vision, her left, towards the web. She flinched and looked up. Had the spider left its web and come for her already?

But it was the Hero. Somehow he'd chased her, kept track of her clumsy arrowing through the sky -- and all without her realizing it, she thought ruefully. He carried his sword, his shining blade of Corestuff, in his bony hand.

...But he was too late; already the first strands of webbing were clutching at her suit, slowing her savagely.

In no more than a few heartbeats she came to rest, deep inside the web. Threads descended before her face and laid themselves across her shoulders, arms and face. She tried to move, but the webbing merely tightened around her limbs. It shimmered silver and purple all around her, a complex, three-dimensional mesh of light.

The web shuddered, rattling her body inside its gleaming suit. The spin-spider was approaching her, coming for its prize...

"Thea! *Thea!*"

She tried to turn her head; thread clutched at her neck. The Hero was swinging his sword, hacking into the web. His muscles were knots under his leathery skin. Thea could see dangling threads brushing against the Hero's bare arms and shoulders, one by one growing taut and then slackening as he moved on, burrowing into the layers of web.

He was cutting through the web towards her.

"Open the suit! It's caught, but you aren't. Come on, girl-  
\_"

She managed to raise a trembling hand to her chest. It was awkward finding the seam, with the web constantly clutching at her; but at last the suit peeled open. The soft, warm stink of spin-spider web spilled into the opened suit.

She pushed away the helmet and drew her legs out of the suit.

The Hero, his crude web-tunnel already closing behind him, held out his hand. "Come on, Thea; take hold--"

She glanced back. "But the suit--" The ancient costume looked almost pathetic, empty of life and swathed in spider-webbing.

"Forget the damn suit. There isn't time. Come *on*--"

She reached out and took his hand; his palm was warm and hard. With a grunt he leaned backward and hauled her from the web; the last sticky threads clutched at her legs, stinging. When they were both clear she fell against him; breathing hard, capillaries dilated all over his thin face, the Hero wrapped his arms around her.

The tunnel in the web had already closed: all that remained of it was a dark, cylindrical path through the layers of webbing.

And, as she watched, the spin-spider's huge head closed over the shining suit.

"I always seem to be rescuing you, don't I?" the Hero said dryly.

"You could have saved the suit."

He looked defensive. "Maybe. I don't know."

"You didn't even try. Why not?"

He brushed his stiff, yellowed hair out of his eyes. He appeared old and tired. "I think I decided that the world had seen enough of that suit -- enough of the Hero, in fact."

She frowned. "That's stupid."

"Is it?" He brought his face close to hers. His voice hard, he said, "It was that moment when I woke to find you inside the suit. I looked through that plate and into your eyecups, Thea, and I didn't like what I saw."

She remembered: *In a moment, she could crush the life out of his bony neck --*

"I saw myself, Thea."

She shivered suddenly, unwilling to think through the implications of his words.



"What will you do now?"

He shrugged thin shoulders. "I don't know." He looked at her cautiously. "I could stay with you people for a while. I'm not a bad hunter, even without the suit."

She frowned.

He scratched at one eyecup. "On the other hand..."

"What?"

He pointed to the south. "I hear the Parz tribe at the Pole are trying to build a city again."

Despite herself, she felt stirred -- excited. "Like before the Core Wars?"

He looked wistful. "No. No, we'll never recapture those days. But still, it would be a great project to work on." He studied her appraisingly. "I hear the new city will be twenty thousand mansheights, from side to side. Think of that. And that's not counting the Corestuff mine they're going to build from the base." He smiled, wrinkles gathering beneath his eyecups.

Thea stared into the south -- into the far downflux, to the place where all the vortex lines converged.

Slowly, they began to Wave back to the Crust forest.

The Hero said, "Even the Ur-humans would have been impressed by twenty thousand mansheights, I'll bet. Why, that's almost an inch..."

*The goals and purpose of the great wars were lost; but still humans fought on, enraged insects battering against the glass-walled lamps of the Xeelee constructs.*

*The Xeelee, unimpeded, appeared at last to take pity. Humanity was -- put aside.*

*But humanity had been a mere distraction. All the while, the Xeelee confronted a much more dangerous enemy.*

# **PART 6**

## **ERA: Flight**

## Secret History

C.A.D. 4,000,000

At last the Project was complete.

The migration alone had taken a million years. While the night-dark Xeelee fleets streamed steadily through Bolder's Ring and disappeared into the folded Kerr-metric region, other races flared in the outer darkness, like candles. Freighters the size of moons patrolled the space around the Ring, their crimson starbreaker beams dispersing the Galaxy remnants that still tumbled towards the Ring like blue-shifted moths.

But now it was over. The Ring, its function fulfilled, sparkled like a jewel in its nest of stars. And the Universe that had been modified by the Xeelee was all but empty of them.

Call it the antiXeelee.

It was... large. Its lofty emotions could be described in human terms only by analogy.

Nevertheless--

The antiXeelee looked on its completed works, and was satisfied.

Its awareness spread across light years. Shining matter littered the Universe like froth on a deep, dark ocean; the Xeelee had come, built fine castles of that froth, and had now departed, as if lifting into the air. Soon the shining stuff itself would begin to decay, and already the antiXeelee could detect the flexing muscles of the creatures of that dark ocean below. It felt something like contentment at the thought that its siblings were beyond the reach of those... others.

Now the antiXeelee turned to its last task. Seed pods, spinning cubes as large as worlds, were scattered

everywhere in an orderly array, millions of them dispersed over the unraveling curve of space. The antiXeelee ran metaphorical fingers over each of the pods and over what lay within: beings with closed eyes, ships with folded wings, refined reflections of the antiXeelee itself.

The work was good. And now it was ready.

...There was a discontinuity. All over the Universe the pods vanished like soap bubbles.

The seed pods' long journey back through time had begun. They would emerge a mere hundred thousand years after the singularity itself, at the moment when the temperature of the cosmos had cooled sufficiently for matter and radiation to become decoupled -- so that the infant Universe became suddenly transparent, as if with a clash of cymbals.

Then the creatures within would unfold their limbs, and the long Project of the Xeelee would begin.

Eventually the Project would lead to the development of the seed pods, the spawning of the antiXeelee itself; and so the circle would be closed. There was, of course, no paradox about this causal loop; although -- for amusement - - the antiXeelee had once studied a toy-creature, a human from whose viewpoint such events had seemed not merely paradoxical but impossible. Something like a smile reflex spread through its awareness. (... And, revived like an afterthought by the immense memory, the toy-creature whispered once more into being, a faint coherence in the vacuum.)

So its work was done; the antiXeelee could let go. It spread wide and thin.

Forgotten, the toy-creature stirred like an insect in its cocoon.

Paul opened his eyes.

The antiXeelee hovered over Paul.

He was -- discorporeal; it was as if the jewel of consciousness which had lain behind his eyes had been plucked out of his body and flung into space. He did not even have heartbeats to count. He remembered ruefully the casual contempt with which he had regarded Taft, Green and the rest on the Sugar Lump, how he had soared over their shambling, makeshift bodies, their limited awareness!

...And yet now, stranded, with no idea why he was here, he would have given a great deal to return to the comforting furniture of a human body.

At least the antiXeelee was here with him. It was like a great ceiling under which he hovered and buzzed, insectlike. He sensed a vast, satisfied weariness in its mood, the contentment of the traveler at the end of a long and difficult road. For a long time he stayed within the glow of its protection.

Then it began to dissolve.

Paul wanted to cry out, like a child after its huge parent. He was buffeted, battered. It was as if a glacier of memories and emotions was calving into a hundred icebergs about him; and now those icebergs in turn burst into shards which melted into the surface of a waiting sea...

With a brief, non-localized burst of selectrons and neutralinos the awareness of the antiXeelee multiplied, fragmented, shattered, sank into the vacuum.

And Paul was left alone.

It was impossible to measure time, other than by the slow evolution of his own emotions.

He had lived among people no more than a few months, on the Xeelee seed pod they had called the Sugar Lump; but in that time he had been shown visions, sounds, scents, tactile images from all the worlds of the human empire, and he had formed an impression of the great storm of souls that constituted the human race. Each of those souls, he knew, was like a tiny line drawn in space-time, with a neat

start, a thickening into self-awareness and a clean conclusion. The race was -- had been -- a vast, dynamic drawing of billions of such lifelines.

He, Paul, spoiled the picture.

His lifeline began in a tight, acausal knot wrapped around the Sugar Lump -- and was then dragged across the face of the picture like a vandal's scribble -- and finished here, a loose end beyond the conclusion of history.

He felt no privilege to be here. His life was artificial, a construct, a random jotting of the Xeelee. He could see inside stars... but he had never looked into a human heart.

He endured despair. Why had he been brought to this point in space-time and then so casually abandoned? Had he been correct in detecting a strain of amusement in the vast, crashing symphony of the antiXeelee's thoughts? Was he truly no more than a toy?

The despair turned to anger, and lasted a long time.

Later he became curious about the aging Universe around him. He had no senses, of course: no eyes, no ears, no fingers; nevertheless he tried to construct a simulacrum of a human awareness, to assign human labels to the objects and processes around him.

There were still stars. He saw sheets of them, bands and rays, complex arrays.

Evidently the Xeelee had remade the Universe.

But there were anomalies. He found many supernova sites, swelling giants, wizened dwarfs: the stars were aged, more aged than he had expected. Clearly many millions of years had passed since his time on the Sugar Lump -- enough time for the Xeelee to have completed their galactic engineering -- yet this immense duration was insignificant on the cosmic scale.

*So why did the stars seem so old?* He found no answer.

Driven by curiosity he began to experiment with his awareness. Physically he was composed of a tight knot of

quantum wave functions; now, cautiously, he began to unravel that knot, to allow the focus of his consciousness to slide over space-time. Soon it was as if he was flying over the arch of the cosmos, unbound by limits of space or time.

He descended through the plane of the Galaxy, his sense-analogues spread wide.

Much of the Milky Way, he found, had been rebuilt. Huge constructs, some light years across, had been assembled: there were rings, sheets, ribbons of stars, stars surrounded by vast artifacts -- rings, spheres, polyhedra. In these celestial cities the component stars appeared to have been selected -- or, perhaps, built -- with great discrimination. Here, for example, was a ring of a dozen Sol-like yellow dwarfs surrounding a brooding red giant; the dwarfs circled their parent so closely that Paul could see how they dipped into the turbulent outer layers of the giant's red flesh. The dwarfs in that necklet must once have been utterly identical, but now time had taken its toll: one of the dwarfs even appeared to have suffered a minor nova explosion -- the shrunken remnant was surrounded by a shell of expanding, cooling debris -- and the rest were fading to dimness, their hydrogen fuel depleted and vast spots disfiguring their shining surfaces.

Throughout the Galaxy Paul found evidence of such decay.

He was saddened by what he saw... and puzzled. He had noted this star aging before; and the time scales still did not make sense.

Something, some agency, had aged the stars.

Paul soared beneath the plane of the Galaxy. The great disc was a ceiling of curdled gold above him. The spiral arms were devastated: made ragged, the spirals disrupted by the blisters of yellow-red light which swelled across the lanes of dust.

Those blisters were supernova remnants. Enduring forced aging, a lot of the more spectacular, and beautiful, spiral arm stars would simply explode, tearing themselves apart... probably there had been chain reactions of supernovae, with the wreckage of one star destabilizing another.

Paul stared up at the wreckage of the disc, the muddled spiral arms.

Some things remained the same, though. Paul saw how the great star system rotated as one, as if solid. The Galaxy's visible matter was no more than a fraction of its total bulk; a vast, invisible halo of *dark matter* swathed the bright spiral, so that the light matter lay at the bottom of a deep gravity pit, turning like an oil drop in a puddle.

Now Paul climbed out of that huge, deep gravity well and passed through the halo of dark matter. The ghostly stuff barely impinged on his awareness. Photinos -- the dark matter particles -- interacted with normal matter only through the gravitational force, so that even to Paul the halo was like the faintest mist.

But he perceived odd hints of structure, too elusive to identify.

Were there worlds here, he wondered, cold stars, perhaps even beings with their own goals and ambitions?

Paul turned away from the Galaxy and faced the hostile Universe.

The quantum functions connecting him to the site of man's original system stretched thin. Soon the human Galaxy shrank to a mote in the vast cathedral of space. He saw clusters and super clusters of galaxies, glowing softly, sprinkled over space in great filaments and sheets, so that it was as if the Universe were built of spiderweb.

On the largest of scales space was a froth of baryonic matter, a chaotic structure of threads and sheets of shining



starstuff, separated by voids a hundred million light years across.

And everywhere, on both the small scale and the large, Paul found evidence of the work of intelligence, and in particular of the vast, unrestrained projects of the Xeelee. They had turned galaxies into neat balls of stars, and in one place they had caused two galaxy clusters -- whole clusters! -- to collide, in order to create a region a million light years wide in which matter was nowhere less dense than in the outer layers of a red giant star.

Paul wondered what manner of creatures moved through that vast sea...

And everywhere he traveled Paul found the premature aging of stars.

Paul's anger stirred, illogically.

Cautiously, clinging to his wave-function ropes, Paul sank into the dark matter ocean.

Currents of photinos swept past him. The moving masses distorted space-time, and the density was high enough for him to perceive vast structures gliding through his focus of awareness. Gradually he came to understand the structure of his Universe.

Dark matter comprised most of the mass of the Universe. Baryons -- protons and neutrons, the components of light, visible matter -- and photinos -- their dark matter analogues -- existed largely independently of each other, interacting only through gravitational attraction.

All matter, dark and light, had erupted from the singularity at the start of time which had forced space itself to unfurl like a torn sheet. The dark matter had spread like some viscous liquid into every corner of the young Universe and, seething, settled into a kind of equilibrium. The baryons had been sprinkled like a froth over this sea.

At first the dark ocean was featureless, save only for variations in its smooth density. These glitches,

representing mass concentrations on the order of millions of solar masses, formed gravitational wells, cosmic potholes into which fragments of light matter fell, pooled, and began to coalesce. Gravitational warming began, and -- finally, fitfully -- the first stars sputtered to brightness. A billion years after the singularity the galaxies formed, trapped like flies in the dark matter wrinkles.

Slowly dark currents pushed the galaxies together, and large-scale structures -- the vast, gaudy superstructure that would span the Universe -- began to evolve.

Most of this made no difference to the dark matter sea... but, here and there, the material of the shining stars began to exert an influence on its dark counterpart. Just as baryons had slithered into dark matter potholes, so -- on a much smaller scale -- photinos collected in the pinpoint gravity wells of the new stars.

Even the human star, Sol, had contained a dark core the size of a moon. Human scientists had observed this dark parasite indirectly by its effect on the neutrino output of the Sun...

And, in a slow explosion of insight, Paul began to see a connection between the dark matter canker at the hearts of the stars, and the aging of the baryonic Universe.

Excited, he skimmed through the Universe, studying the cooling corpses of extinguished stars.

And at last, datum by datum, he came to understand the secret history of the Universe.

Thanks to the baryonic stars small-scale structure entered the dark matter Universe. Paul speculated that a chemistry must have begun, with varieties of the photinos combining to form some counterpart of molecules; strange rains had sleeted over the surfaces of the shadow worlds, still buried in the blazing cores of baryon stars.

At last life had arisen.

Paul had no way of knowing if the transition to life had occurred on one of the shadow planets or on several,

perhaps in a variety of forms. Nor could he guess what form that life had taken, what technologies and philosophies it had evolved.

But he could speculate how it had spread. Photino creatures like birds -- photino birds -- had fluttered out through the baryon stars as if they did not exist, colonizing shadow world after shadow world. Perhaps, Paul supposed, vast flocks had plied between the hearts of stars, with the humans and other baryonic races all unaware.

Aeons had passed with the two grand families of life, dark and light, oblivious of each other...

Then something had happened.

Again Paul could only guess. Probably a supernova had ripped apart a baryon star, laying waste to its host shadow world in the process. Paul imagined the horror of the photino civilization as the irrelevant froth of baryons through which they moved turned into a source of deadly danger, perhaps threatening the ultimate survival of their civilization.

Many courses of action must have been considered, including -- Paul speculated with a kind of shudder -- the total annihilation of the baryonic content of the Universe. But without baryon stars and their tiny gravity wells new shadow worlds could not form; therefore without the baryons there could be no replacement for the photino worlds as they grew stale and died: and so, in the end, the dark civilization itself would falter and fail.

So the baryons had to stay. The photino birds needed the stars.

But they didn't need the damn things exploding all over the place. And the Universe was full of these vast, gaudy stars, burning off energy and forever quivering on the brink of catastrophic explosions. Such extrovert monsters were simply unnecessary; all the dark races required from a star was a reasonably stable gravity well. The remnants of large stars -- white dwarfs and neutron stars -- were quite

satisfactory, and so were immature stars: the brown dwarfs and Jovian gas planets which were warm but not quite large enough for fusion to be initiated.

Cold, dull, and immensely stable. That was how a star should be.

So the photino birds set out to transform the Universe.

The photino birds set up two great programs. The first had been to shape the evolution of new stars. Paul imagined invisible flocks cruising through the vast gas clouds which served as the breeding grounds for new stars; the photino birds had used huge masses to skim layers off protostars and so condemn them to become brown dwarfs, little grander than Jupiter.

The second program had been to rationalize existing stars.

If the things were going to explode or swell up like balloons, the photino birds had reasoned, then they would prefer to accelerate the process and get it out of the way. Then the photino civilization could grow without limit or threat, basking in the long, stately twilight of the Universe.

So the photino birds had settled into the hearts of stars. They infested the core of humanity's original Sun.

For millions of years, unknown to humanity, the photino birds had fed off the Sun's hydrogen-fusing core. Each sip of energy, by each of the photino birds, had lowered the temperature of the core, minutely.

In time, after billions of interactions, the core temperature dropped so far that hydrogen fusion was no longer possible. The core had become a ball of helium, dead, contracting. Meanwhile, a shell of fusing hydrogen burned its way out of the Sun, dropping a rain of helium ash onto the core...

Five billion years early, the Sun left the Main Sequence, and ballooned into a red giant.

With such cool calculation, such oceanic persistence, the photino birds made the stars old.

Soon the first supernovae began. They spread like a plague from the photino birds' center of operation.

And the Xeelee became troubled.

By this time, Paul speculated, the Xeelee were already lords of the baryonic Universe. They had initiated many of their vast cosmic engineering projects, and a host of lesser races had begun to dog their gigantic footsteps.

The Xeelee focused attention on the photino birds' activities, and rapidly came to understand the nature of the threat they faced. In peril was not just the future of the Xeelee themselves, but of all baryonic life.

Perhaps they had tried to communicate with the birds, Paul speculated; perhaps they even succeeded. But the conflict with the photino birds was so fundamental that communication was meaningless. This was a dispute not between individuals, worlds, even species; it was a struggle for survival between two inimical life modes trapped in a single Universe.

It was a struggle the Xeelee could not afford to lose. They abandoned their projects and mobilized.

The final War must have started slowly. Paul imagined Xeelee nightfighters descending on stars known to harbor key photino bird flocks, cherry-red starbreaker beams shining like swords. And there would be reciprocal action by the photino birds; their unimaginable weapons would slide all but unobserved past the best defenses of the Xeelee.

And the Xeelee must, about the same time, have initiated the construction of the great causal loop controlled by the antiXeelee with its seed pods. At last Paul understood the antiXeelee's purpose: the Xeelee had, with awesome determination, decided to modify their own evolutionary history in order to equip themselves for the battle with the photino birds. Paul pictured a branching of the Universe as the antiXeelee changed the past. The Xeelee, modified and pre-warned, had time in this new

history to prepare for the coming conflict, including the construction of the mighty artifact called Bolder's Ring -- an escape route in case, despite all their preparation, the War were lost.

And all the time humans and other races, oblivious to the great purpose of the Xeelee, had scrambled for abandoned Xeelee toys. Eventually humans had even had the audacity to attack the Xeelee themselves, unaware that the Xeelee were waging a total War against a common enemy far more deadly than the Qax, or the Squeem, or any of man's ancient foes.

The Xeelee wars had been a ghastly, epochal *error* of mankind. Humans believed they must challenge the Xeelee: overthrow them, become petty kings of the baryonic cosmos.

This absurd rivalry led, in the end, to the virtual destruction of the human species. And -- worse, Paul reflected -- it blinded humanity to the true nature of the Xeelee, and their goals: *and* to the threat of the dark matter realm.

There was a fundamental conflict in the Universe, between the dark and light forms of matter -- a conflict which had, at last, driven the stars to their extinction. Differences among baryonic species -- the Xeelee and humanity, for instance -- are as nothing compared to that great schism.

And, even as the wars continued, still the cancer of aging, swelling and exploding stars had spread. The growth of the disrupted regions must have been little short of exponential.

At last the Xeelee realized that -- despite the deployment of the resources of a Universe, despite the manipulation of their own history -- this was a War they could not win.

It remained only to close the antiXeelee's causal loop, to complete the Ring, and to flee the Universe they had lost.

But already the birds were gathering around the Ring, intent on its destruction.

Paul brooded on what he had learned, on the desolation of the baryonic Universe which lay around him. Though the Ring survived still, the Xeelee had gone, evacuated.

Baryonic life was scattered, smashed, its resources wasted -- largely by humanity -- on absurd, failed assaults against the Xeelee.

Paul was alone.

At first Paul described to himself the places he visited, the relics he found, in human terms; but as time passed and his confidence grew he removed this barrier of words. He allowed his consciousness to soften further, to dilute the narrow human perception to which he had clung.

All about him were quantum wave functions.

They spread from stars and planets, sheets of probability that linked matter and time. They were like spiderwebs scattered over the aging galaxies; they mingled, reinforced and canceled each other, all bound by the implacable logic of the governing wave equations.

The functions filled space-time and they pierced his soul. Exhilarated, he rode their gaudy brilliance through the hearts of aging stars.

He relaxed his sense of scale, so that there seemed no real difference between the width of an electron and the broad sink of a star's gravity well. His sense of time telescoped, so that he could watch the insectlike, fluttering decay of free neutrons -- or step back and watch the grand, slow decomposition of protons themselves...

Soon there was little of the human left in him. Then, at last, he was ready for the final step.

After all, he reflected, human consciousness itself was an artificial thing. He recalled Green, on the Sugar Lump, gleefully describing tests which proved beyond doubt that the motor impulses initiating human actions could often

precede the willing of those actions by significant fractions of a second. Humans had always been adrift in the Universe, creatures of impulse and acausality, explaining their behavior to each other with ever more complex models of awareness. Once they had believed that gods animated their souls, fighting their battles through human form. Later they had evolved the idea of the self-aware, self-directed consciousness. Now Paul saw that it had all been no more than an idea, a model, an illusion behind which to hide. Why should he, perhaps the last human, cling to such outmoded comforts?

There was no cognition, he realized. There was only perception.

With the equivalent of a smile he relaxed. His awareness sparkled and subsided.

He was beyond time and space. The great quantum functions which encompassed the Universe slid past him like a vast, turbulent river, and his eyes were filled with the gray light which lay behind all phenomena.

Space had never been empty.

Within the tight space-time limits of the Uncertainty Principle, "empty" vacuum was filled with Virtual particle sets which blossomed from nothing, flew apart, recombined and vanished as if they had never been -- all too rapidly for the laws of mass/energy conservation to notice.

Once, human scientists had called it the seething vacuum. And now it was inhabited.

The Qax was a creature of turbulent space, its "cells" a shifting succession of Virtual particle sets. Physically its structure extended over many yards -- a rough sphere gigantic in subatomic terms containing a complex of Virtual particle sets which stored terabits of data: of understanding, of memory stretching back over millions of years.



Like the shadow of a cloud the Qax cruised over turbulent space, seeking humans...

## **PART 7**

### **ERA: Photino Victory**

*...Is it over? Is humanity destroyed? Lethe, Eve, we've covered millions of years. We've seen the flight of the Xeelee, the victory of those photino birds. It must be over. What can be left to show me?"*

*"Watch," she said patiently. "Watch..."*

# Shell

**A.D. 4,101,214**

"I've found a bird from the Shell -- a bird from space!" Allel ran into the village bursting with her news, her baggy bark shirt flapping.

But nobody was impressed. She couldn't understand it. Younger children turned back to their games in the dust.

Her mother, Boyd, absently cuffed Allel's fourteen-year-old head. "Don't bother me," she growled, and went about her business.

Boyd's face was a scarred, complex mask as she moved amongst the groups of men and women, massive and formidable in her coat of quilted cow-tree bark, planning and talking urgently. It was already late afternoon; that evening Boyd would be leading this ragged army south in another assault on the defense of the Bridge.

Allel knew how important this was to her mother; eventually they had to secure a crossing over the river Atad and gain access to the south -- otherwise the northern glaciers would surely crush their tiny village before many more winters. Boyd's fists were clenched white as she argued. Allel knew she was brooding over the prospect of another bloody failure, and decided to keep out of her way.

She found her grandfather, Lantil, ferrying bowls of excrement and other waste from the bark teepees to the clusters of cow-trees at the heart of the village. Lantil dumped out the bowls into the trees' root systems and tiredly tolerated his granddaughter's chatter.

She told him how she'd gone out of the village alone and scrambled over the rocky shoulders of Hafen's Hill, a mile or so away. At the summit she'd thrown herself flat,

panting, and stared up in wonder: in the afternoon light the Shell was a glowing quilt, and she'd soon forgotten the wind from the northern ice fields that probed at the crude seams of her shirt...

Allel's was a world without a sky. Instead the Shell swept from horizon to horizon, covering the land like a glowing lid of blue, green and startling orange. She'd traced the familiar lines of the ocean boundaries and watched clouds wind themselves into an upside-down storm directly above her. She reached up a finger as if to stir the storm on that great plate hanging over her--

-- and the bird had tumbled out of the air. She'd scuttled to her knees and cupped the bird in her hands; its heart rattled as ice droplets melted from its wings.

The bird was an ice blue, a spectacular color she'd never seen before. And in its beak was a vivid orange flower.

The precise color of those strange orange splashes on the Shell.

The bird recovered and clattered away, but that didn't matter. Allel knew it must have lost its way and crossed the Gap between the worlds.

She'd run off down the heathered slopes to her home.

She dogged Lantil's footsteps as he trudged wearily among the teepees. "But if the world and the Shell are globes, what holds them apart?" Perhaps there were great pillars beyond the horizon...

Lantil pushed a lank of dirty hair back from his brow. "What does it matter?"

"I want to know," she stamped.

Her grandfather sighed. "All right." He knelt beside Allel and made a gnarled fist. "There's the world, Home, round like a ball." He cupped his other hand around the fist. "And there's the Shell, a hollow sphere around Home." Now he broke the fist and twirled a fingertip in a helix inside the cupped hand. "The Sun moves through the Gap, giving us day and night, summer and winter."

Allel nodded impatiently. "I know all that. But who built it all?"

"People, of course." He straightened up, massaging his back. "To keep out monsters called the Xeelee."

Allel, wide-eyed, imagined giants stalking beyond the Shell, beating their fists against ocean bottoms and tree roots.

"Now I've got to get on," Lantil snapped. "Get on with you, child. Get on..." Grumbling, he went back to his chores.

Allel ran off, savoring her newest fragment of knowledge. She imagined flying up to a saucer-shaped land where a world hung in the sky, a ball plastered with rocks and trees.

The next morning she rose at dawn. She pushed her way out of the teepee's bark flap, letting the gray cold scour out her night fug. She shivered her way to a cow-tree and sucked icy milk from one of its nipples.

The village was hushed in the continued absence of the warriors. A group of old folk and children were at work already, making the most of the precious summer day; they were peeling a fresh sheet of clothlike bark, barely formed, from one of the cow trees. Allel peered furtively up at the Shell. The morning terminator was a gray bar that straddled the horizons, scouring eastward. The night lands beyond were broken by flickering sparks: fires that showed that people lived on the Shell, like flies on that great ceiling.

She'd brought a small bark satchel from the teepee; now she arranged it over her shoulder and scurried over the rough track to Hafen's Hill. From the summit she could see the Atad river, a glistening track to the south; the Bridge looked like an indestructible toy, one of the few of the old structures not yet swallowed by the ice. Smoke blurred the scene. She wondered if that was a good sign.

She soon forgot the distant battle as she got to work. She opened her satchel and drew out a small lamp, a gourd filled with alcohol fermented from cow-tree fruit. She cut a length of wick with the big stone knife her grandfather had made for her. She held a flint to the wick; it curled and popped as black smoke seeped into the crisp air. Now she opened out a small bag, a rough globe. She held its narrow neck over the flame, and soon her fingers were coated with lamp-black--

-- and the simple balloon filled up and lurched a few feet into the air. Then it turned belly-up and flopped to the ground. Allel bared her teeth at the Shell as if she owned it already; her heart beat as had that lost bird's. Now then, a little more weight around the mouth...

A sandal stamped down, crushing the balloon. The bark of the sandal was crusted with blood and dust.

"Get up." Boyd spat the words; blood leaked from a new wound over her eyes.

Allel stood, furious. Her anger collided with her mother's contempt. Save for the scars of battle, the years had been easy on Boyd. Mother and daughter faced each other like twins, images in a dark mirror.

"Our attack on the Bridge failed," Boyd ground out. "Those bastards holding it want to keep the whole bloody south to themselves. Good people died. And you -- you won't even help the old folk with their chores. What do you think you're doing?"

Allel picked up the sputtering lamp. "I doubt if you'd understand," she said haughtily.

Boyd slapped the lamp from her hands. It smashed against a rock; alcohol pooled and puffed into flame. "You waste your time on rubbish. Don't dare to speak to me like that."

Allel bit back her rage. "I fill the bag with smoke. It flies. Build one big enough and I could fly with it--"

"More rubbish." Boyd hawked and spat out a ball of bloodstained phlegm; it sizzled in the alcohol fire. "If it's ever left up to you, we'll all die of rubbish." She grabbed a handful of Allel's tunic; her breath was sour. "Or I'll kill you first. And that's not rubbish." She strode off down the Hill's broken flank. "Come on. You'll be grown soon. It's time I put a stop to your questions."

Allel didn't move. "Where are we going?"

"North. To the place where our people once lived, before the cold drove them out. North to the City."

"Why should I come?"

Without looking back, Boyd said simply: "Because if you don't I'll break your rubbish neck."

Allel looked back ruefully at her home, where the fires of the recent night were still burning. Then she clutched her crumpled shirt closed against the wind and followed her mother.

The breeze lifted the abandoned balloon; its final flight ended in the ruins of the lamp, where it began to burn fitfully.

The Sun wove its helical web around the world.

When night fell Boyd and Allel sheltered beneath a wild cow-tree. In silence, they drank from its milk nipples and broiled slices of meat fruit over a small fire. Boyd slept sternly beneath her quilted coat. Allel shivered in her thin garments, and burrowed into a nest of leaves. She peered up sourly at the Shell's seamless dark, picking out clustered fires.

In the morning she stuffed leaves inside her clothes and fashioned herself a rough cap of cow-tree bark.

After some days of this the frost grew more persistent, until their feet crunched over thin ice. Light snow fell. They passed a few abandoned settlements; even the hardy cow-trees grew sparse here.

A blizzard closed around them like a white mouth. They staggered up to the milkless corpse of a cow-tree. Allel stared at the shrunken nipples and withered fruit. Boyd laughed at her, her eyelids sprinkled with snowflakes. "Comes as a shock, doesn't it? A dead cow-tree. We were given a world filled with beautiful buildings, and cow-trees to feed and clothe us like mothers. A home safe from the Xeelee.

"But the world's old and falling apart. The Sun seems to be failing. Ice has covered the cities and frozen the milk in the cow-trees. We trudge through the snow." She began digging into the snow packed against the dry wood. "Come on. We'll let this lot blow itself out. The snow will keep you warm."

As she worked, Allel considered a changeless life of endless summer. What would there be to do all day? Her bare fingers grew numb.

When the storm blew over they continued the journey. With the Shell like a map over them it was impossible to get lost, and at last they came to the lip of a great natural bowl. Snow pooled around the low buildings of the City, which were sprinkled in two matching crescents.

Allel, used to crude teepees of cow-tree bark, touched walls that were as smooth as skin. But the interiors were cold and jumbled, and snow drifted waist-deep in the avenues.

Lifting heavy legs out of the snow, they forced their way to the common center of the City's twin crescents. Here was a small cylindrical building, no more than three paces across. Allel helped her mother scrape snow from the door. Boyd blew on damp fingers. "Go ahead," she said slyly. "You first." Allel pushed through the light door--

-- and stared in astonishment at the far wall of the chamber, at least a hundred paces away. She stumbled backwards and landed in the snow, which soaked into her thin trousers. Boyd laughed, not unkindly, and hauled her



to her feet. "A vast hall crumpled into a tiny hut. The people who built this had powers even you never imagined, eh?"

Allel stumbled around the tiny building. Where was all that space stored? If not sideways -- or behind -- or up, or down -- what fourth direction was there? The puzzle settled behind her eyes like a spider.

The floor area was empty, but the paper-thin walls were covered with pictures, still lit and animated after uncounted generations. "The pictures tell our story," Boyd said gruffly. "How we rose and fell." She stamped snow from her sandals and led the way around the walls. Afterwards Allel thought they could have walked in the opposite direction and lost little of the sense, for the story of humankind had a symmetrical design.

The bright side of the symmetry was expansion. From a world without a Shell, tiny ships like streamlined fish swam out on hyperdrive to the stars...

"What was 'hyperdrive'? And 'stars'?"

They were just words, Boyd said, passed on by other mothers on other days. Allel wondered if her balloon had risen on hyperdrive. She looked closely at the ships but could see no sign of burners. She tried to touch the picture-

-- and her hand passed into the depthless wall, in a direction she could not identify. She fingered a model ship; it was like a nut drawn on an invisible string. More mysteries...

At its peak humanity was a master of many stars -- which were evidently places very far away. And then--

"And then we met the Xeelee," said Boyd, and they inspected a harrowing battle scene. Elusive fingers snatched at the little ships. "Whoever they were, they were too big for us."

After the Xeelee wars came the dark obverse of humanity's conquest of the stars: its sad subsidence back to its home world, prodded by the dark fingers of the Xeelee.

They came to the last two panels. Boyd said: "Finally we returned to our home and rebuilt it as a place safe from the Xeelee." The first panel showed a sphere, blue capped with fat brown poles. Painted onto the central cerulean band were clouds and a tiny Sun that twinkled along the equator. The fringes of the polar caps held a lot of detail: sideways-on pictures of trees and men, oriented as if the clouds were "up" and the poles were "down." "I don't understand this one," Boyd admitted. "Maybe it was a stage in the Shell's construction. But here's the world as it is now." The last image was crudely sketched on the surface of the wall, with no depth or animation. It showed a globe with a Shell around it. Allel picked at flaking paint. Boyd coughed self-consciously. "So, you understand now why I brought you here?"

Allel inspected paint dust. "This is just dyed cow-tree milk. This last picture must have been added much later--"

Boyd swore. She spat on the smooth floor and stalked out.

...And, thought Allel, excited, in that case maybe the world was more like the other image, the blue sphere. But what did it mean? Everyone knew there was a Shell around the world -- you could *see* it...

She became aware of her mother's absence. Cursing, she hurried out.

Boyd stood a few paces from the door, fists clenched. Feathers of snow drifted around her legs. "I repeat. Why do you think I brought you here?"

Allel tried to concentrate on the question. "To show me this place? To tell me its story?"

"Yes!" The trackless snow softened Boyd's shout. "Once we rebuilt the whole world, but now we can't even melt a few glaciers." She gripped her daughter's shoulders, not roughly. "People got soft and forgot. Allel -- if I fail, you've got to carry on. Perhaps it will fall to you to take over, and

lead our people to the Bridge. That's the truth of our world, the only truth. The only way to save ourselves that's within our power."

Allel returned her mother's fierce stare. "I understand, but..."

Boyd sneered: "But you want to ask the Shell dwellers what it's like living in a saucer." Her eyes were flat, impervious to the hard cold. Allel wondered how she and her mother had grown so far apart, becoming as symmetrical as opposing poles. The one pragmatic, the other -- a visionary? -- or a fool? Who was right? Perhaps that was a question without an answer--

She knew Boyd was trying to force her to grow up. But the Shell arced over them like a roof coated with its own ice. Could she give up all her dreams and become a creature of her mother?

"Listen," she said desperately. "I've thought of a way we can take the Bridge."

Her mother whirled and drove her palm against Allel's cheek. Blood pumped into Allel's mouth and strange scents flooded her head.

"You've learned nothing," Boyd said hoarsely. "I'd rather leave you here." She forced herself forward, fists clenched white.

Allel mumbled: "I mean it." She felt blood freezing on her lip. She became aware she'd lost her cap. But Boyd was hesitating.

"How?"

"If I succeed..." She coughed and spat blood. It was vivid against the snow. "If I succeed, will you help me build a hyperdrive machine to fly to the Shell?"

Boyd's eyes narrowed. "I don't believe it. You're bargaining with me..." Then she dug a bark handkerchief out of a voluminous pocket. "Here. Clean yourself up."

The dozen warriors converged on the Bridge. They wielded branches hacked from cow-trees, their miraculous meat buds smashed away. To Allel, watching from above, the crude clubs were symbols of the depressing symmetry of humanity's rise and fall.

The Bridge was a gleaming parabola plastered with teepees. From the teepees defending warriors emerged, grubby and yelling, brandishing rocks and clubs. Blood splashed over the seamless carriageway. But soon it was hard to separate the two sides, but Allel could see that as before the attackers were being driven away.

The breeze picked up and the great balloon over her creaked into motion, its stitched bark straining. The canvas sling chafed her armpits, and she tended the alcohol burners clustered like berries just above her head. The balloon wallowed in the air. Soon its load would be lighter, she thought, uncertain of her feelings.

Her shadow drifted over the melee, touching fighters, men and women alike, who wriggled together like blood-soaked termites. They looked up in fear or anticipation. She took a small alcohol lamp, one of a cluster tied to her belt. She lit the lamp, cut its cord with her stone knife, and dropped the lamp delicately into the defenders' muddled line. The lamp flared into flame; a toy man ran screaming, his shirt a torch. Another lamp, and another. Cries of anger sailed up at her, followed by whirling clubs. No weapons could reach her, and she dropped her lamps. Then the defenders' line broke and the battle surged across the Bridge. Teepees crumpled, and old folk screamed. Allel thought she heard her mother shout in triumph.

Her lamps gone, Allel dropped the pouch and the balloon rose further. She stared up at the Shell's complex tapestry and waited for a breeze to take her home.

She found the teepee's air filled with her mother's sweat and dirt. Boyd's left wrist was a stump of torn blood vessels

and shattered bone. It had been cauterized; now Lantil bathed it with milk and tears. Boyd took Allel's forearm in a grip that pulsed with pain. "Daughter! Your damn bag of smoke worked..."

Allel tugged gently, wanting only to be released. "Yes. And now you'll have to help me build a real machine to cross the Gap."

Lantil pushed at Allel's chest, his liver-spotted hand fluttering like a bird. "You should be ashamed to speak to her that way. Can't you see she's hurt?"

But Allel kept her gaze locked with her mother's.

Slowly Boyd grinned. "Won't give up, will you? Determined to prove me wrong. All right. On one condition."

"What?"

"Take me, too. I've done my job here; maybe I want to see the Shell people, too... ah..."

The pain silenced her. Lantil pulled his daughter's blood-spattered head against his chest.

Allel loosened her mother's grasp, and went to her pallet to start her plans. She lay with her face to the bark wall.

The whole village turned out for the launch. They nudged each other and pointed out panels on the balloon which they themselves had helped stitch, forgetting Boyd's five years of bullying.

Impeded by their harnesses, Boyd and Allel labored at the bellows-like fuel pumps. The great bark envelope filled slowly, throwing swollen shadows in the flat morning light. Allel eyed the low Sun warily. They'd timed their flight to avoid a collision -- fantastic though such a prospect seemed. But, she had reasoned doggedly, the Shell was behind the Sun. They were going to fly to the Shell. Therefore they could hit the Sun, and had to navigate to avoid it.

Her harness twitched twice, as if coming awake -- and then, with a surprising surge, lifted her. The ground tilted away. People gave a ragged cheer and children chased the balloon's shadow. Boyd roared and waved her good hand at them. Her crippled arm was lashed to the rigging. "We're off, daughter!" she bellowed.

The landscape opened out and swallowed up the huddled villagers. To the north the Atad river curved into view, and beyond the site of their old home Allel could see the glaciers prowling the horizon.

She felt she was floating into a great silent box. The balloon's throat occluded the Shell's upside-down clouds. She hoisted herself into the rigging to tend the burners, prizing the stubby wicks from the resin-soaked barrels of alcohol. Gritty sweat soaked her eyes. She'd insisted they both wear quilted coats despite Boyd's protests; she remembered the frozen ice-blue bird she'd found on Hafen's Hill on another summer day, five years ago.

And sure enough, not many minutes later the dampness at her neck chilled and dried. Her breath caught and soon grew labored. "Even the damn air has a Gap here," growled Boyd. "But you know, this harness isn't chafing so much as it did."

Allel, too, felt oddly light; she had a sensation of falling. But they rose smoothly into blue silence. Soon they were miles up; clouds dissolved as they passed into them. Their world collapsed to a Shell-like map, shutting them out; above and below became symmetrical and Allel's stomach lurched.

Their rate of ascent slowed. The breeze in the rigging grew softer. The craft lumbered, unstable.

"What now?" demanded Boyd uneasily. "Watch the burners."

"Yes. I wonder if -- ah. The burners! Quick!"

The balloon was collapsing.

They worked grimly, dragging themselves into the rigging and cutting away the burning wicks. The envelope crumpled over the doused lamps.

And Boyd was upside down.

Or Allel was.

Her harness was slack. The components of their balloon drifted in a jumble. Boyd thrashed in the air as if drowning -- but there was no *up* to kick towards. Fear showed beneath her pale scars.

But Allel understood.

"It's the middle of the Gap!" Allel yelled, exhilarated by her mother's discomfiture. "The Shell dwellers live upside down. Up for us is down for them. Did we think we'd fly up and bump against the Shell like a ceiling? This is the place where up and down cross over!" Warm air spilled from the balloon and brushed her face. Ground and Shell were enormous parallel plates that careened identically around her. She laughed and swooped.

But their equilibrium in the weightless zone was unstable, and soon invisible fingers clutched at them. Wind whistled in the tangled rigging and their harness grew taut again. "We're falling back!" Allel cried in disappointment. Boyd struggled to keep her good arm free.

Now air resistance roughly righted them. The balloon opened out like a parachute but scarcely slowed their fall.

Boyd roared above the wind: "We've got to light the burners!"

They hunted for flints and cupped their hands around the wicks to keep out the snatching breeze. Heat roared up. Boyd thrust at the fuel pumps while Allel scrambled precariously into the tangled rigging to drag at the neck of the envelope, trying to trap all the warmed air.

Their descent slowed a little. Allel's arms ached and her hair whipped at her forehead. The ground exploded into unwelcome details, rivers and hills and trees and pebbles--

She rolled on impossibly hard earth, grass blades clutching at her face. Her blood was loud in her ears. The balloon folded as if wounded.

In a sunlit meadow, mother and daughter lay amid the ruins of their bark spaceship.

Sunlight scoured her eyes. Allel sat up, blinking, pushing at the knotted remains of her harness. She was surrounded by cool grass and flowers; a brook led to a stand of cow-trees and the horizon was made up of heather-coated hills.

And, as it had always done, the Shell curved over it all like a great blue tent.

Boyd slept peacefully in a tatter of the balloon. Allel hesitated for some minutes, vaguely fearful of her mother's reaction. Then she found a remnant of a shattered burner and woke her mother with a cup of brook water. Boyd sat up clumsily, favoring her bad arm.

"We failed," Allel said.

"Huh?"

Allel pointed at the Shell above them. "Look. We must have fallen back. If we'd reached the Shell we'd see the world up there, a ball of rock, cupped by the Shell. And the land would tilt up at the horizon..."

Boyd grunted. Sensitive to her daughter's mood, she drank in silence. She probed at her limbs. "At least we're still whole," she rumbled. She looked about. Then -- unexpectedly -- she grinned. "So we failed, did we? Eh?"

She dug her good hand into the ground, and then shook it in Allel's face. "Look at that! Look!"

At the heart of the clump was a bright orange flower. A Shell flower.

Allel's thoughts swam like fish. "Now I really don't understand..."

"We made it. We're on the Shell! That's enough for me." Then Boyd followed her daughter's gaze upwards, to the roof over the world. Her eyes narrowed.



Allel said slowly, "Above us we see Home, not the Shell. Yet it looks as the Shell does. The two worlds are complete in themselves, yet they are -- wrapped around each other. Symmetry. You see the same thing -- a Shell -- from whichever world you're on."

Boyd nodded shrewdly. "Well, that much I understand. Like us, eh? Two halves of the same whole. No weak center, no protecting Shell. Just the two of us."

Allel dropped her eyes, hotly embarrassed. She went on doggedly: "But how? If we're on the Shell, why doesn't the land curve up like a saucer? Why don't we see Home floating up there like a ball? How *can* it look like another Shell?"

Boyd made a little growling noise, and flung the shard of burner into the grass. A small flock of ice-blue birds clattered off, alarmed. "Well, you're the dreamer. Dream up an answer."

Allel lay flat. She rested her head on very ordinary loam and stared up through two layers of clouds. She thought of two worlds, each a ball yet each cupping the other like a shell round a nut. How could that be?

Her vision of her universe was crumbling, like the flaking planet-in-a-box milk painting on that museum wall. She imagined reaching into the box to the truth--

Boyd said gruffly: "Well, what now?"

Allel gestured vaguely. "Fix the balloon and get home. We've got to make people understand. Build more balloons and go to the old Cities. Find a way to turn back the glaciers, or fix the Sun..."

Boyd was staring past her shoulder. Allel turned -- then sat up quickly.

The boy stood at the edge of the stand of cow-trees. He was no better dressed than they were; teeth flashed in a dark face as he jabbered at them, smiling and pointing and cupping his hands.

Allel watched, baffled. "What's he saying?"

Boyd bellowed with laughter. "I think he's asking what it's like living in a saucer."

Boyd stood up and, with some dignity, straightened the shreds of her quilted jacket. Allel got to her feet, stiffly. "Come on," said Boyd. "Let's see if his people can cook as well as your grandfather."

They walked towards the boy across the meadow of bright orange flowers.

*"Lethe. I can't believe they fell so far. They've become utterly dependent on that artificial biosphere. They're reduced to technologies of stone and wood--"*

*"But they survived," Eve said. "Humans survived, even beyond the evacuation of the Xeelee. In a world that cared for them. You could argue this is a Utopian vision..."*

*"This world of theirs, with the Shell, is a four-dimensional sphere. No wonder they couldn't figure it out."*

*I thought of three-dimensional analogies. Allel's people were like two-dimensional creatures, constrained to crawl over the surface of a three-dimensional globe. Home and Shell, the twin worlds, were like lines of latitude, above and below -- each unbroken, each apparently cupping the other. Just as the diagrams in the "City" had tried to show them.*

*"But they were capable of understanding," Eve said. "After a million years, humans had adapted in subtle ways. Allel had the capacity to visualize, to think in higher dimensions. She could have understood, if someone had explained it to her. As those diagrams in the place she called the City were meant to. And in time, she would figure out some of it..."*

*"They were trapped," I said. "In a prison of folded space-time."*

*"Perhaps," said Eve. "Perhaps. But they didn't give up..."*

# The Eighth Room

**A.D. 4,101,266**

Teal slept through dawn.

He woke with a jolt. There was the faintest crack of red around the teepee's leather flap.

After all his planning... it would be broad daylight by the time he reached the bridge anchor.

But, he reflected ruefully, there was a certain irony. The dawn had been too feeble to wake him -- and that was the heart of the problem.

The Sun was going out. And today Teal was going to try to fix it.

With a fluid movement he slid off the pallet and stood in the darkness.

Erwal's breathing was even and undisturbed. Teal hesitated; then he bent and touched his wife's belly, his fingertips exploring the mummy-cow skin blanket to find the second heartbeat beneath.

Then he pulled on his clothes and slipped out of the teepee.

His breath steamed. Dawn was an icy glow; a roof of snow-laden cloud hid all sight of Home, the world in the sky.

He walked softly through the heart of the little village. The ground was corrugated by mummy-cow hooves. He stepped around piles of bone needles and broken stone tools, past heaps of lichen and moss gathered to feed the cows.

Frost crackled.

He glanced about uneasily. Nobody knew what he was planning today, and he didn't want to be spotted by any

early risers...

But all the dozen teepees were silent. Even the one belonging to Damen, Teal's elder brother. If Damen knew what he was up to, he'd knock Teal senseless.

He found himself tip-toeing away like a naughty child.

He reached the border of the village and began to lope across the tundra, his breathing easier. His even pace ate up the silent miles and the sky was barely brighter when he came to the bridge anchor.

The anchor itself was an arch about the height of a man, made of something smooth and milky-white. The structure's original purpose was long forgotten, dating from before the ice. It was unimaginably old.

Now, though, there was a rope tied to the crosspiece. The rope rose from the arch and pierced the clouds, as if it were tethering the sky... but, Teal knew, the rope looped on past the clouds and crossed space to another world.

He approached the anchor past tarpaulined bundles of balloon equipment. Huddled around the arch were five mummy-cows. Humming simple songs they picked at the rope's knots with their articulated trunks.

"Get away from that rope."

The great soft beasts cowered at his voice. In their agitation they bumped together, trembling. Their ears flapped and their food teats wobbled comically.

Finally one of the cows broke out of the group and approached nervously. "Pardon, ssir..."

The cow was a broad fur-covered cylinder supported on stumplike legs. Her rectangular head rotated mournfully around a single ball joint, and plate-sized eyes looked down at Teal. From the center of the blocky face sprouted a bifurcated trunk, and humanlike hands at the ends of the trunk's forks pulled at each other nervously.

The other mummy-cows giggled and whispered.

"Well?"

"Pardon, ssir, but it iss... needed to move the rope today. It is the Su-Sun, ssir..."

"I know about the Sun. Listen to me: I need your help. What's your name?"

"Orange, ssir..."

"Well, Orange, I intend to take up a balloon. Go and fetch the envelope and tackle. You know what that means, don't you?"

"Yess. I often help with flightss. But the Su-Sun will come t-too close today..." The great floppy mouth worked in agitation.

"That's the idea," he snapped. "I don't *want* to avoid the Sun. I'm going up to it. All right?"

The other mummy-cows, startled, whispered together. He silenced them with a glare, his breath quickening. If they suspected he was here without the knowledge of the rest of the village they wouldn't help him.

But Orange was looking at him steadily. "The Su-Sun is going out, isn't it, s-ssir?"

"You know about that?" Teal asked, surprised.

"We live a long time," said Orange. "Longer than people. Some of us notice things... Today the Su... the Sun is orange. But once it was yellow... in the da-dayss when Allel arrived in the f-first balloon from Home."

The other mummy-cows nodded hugely, pounds of flesh rippling in their cheeks.

Teal felt obscurely sorry for the mummy-cows, moved to speak to them, to explain. "Even then the world was growing cold," he said. "My grandmother crossed the Gap to find the answer. After that people were excited enough to build this bridge, so now we can travel between the worlds whenever we like.

"But in the end Allel failed. The Sun's still cooling, and she found no answer."

"But you will... fix-x it, ssir?"

Teal laughed. If only he could find a human with such imagination -- "Maybe."

The dawn stained the sky a little brighter. Soon the village would be stirring; he had to be aloft quickly--

There was an odd shrewdness in Orange's brown eyes. "I... w-will help you." She turned and made her way to one of the piles of balloon equipment. With her articulated trunk she pulled at a bark tarpaulin.

His heart lifting, Teal shooed the other cows away from the rope anchor and began to check the knots and stays.

The morning was approaching its murky peak by the time Teal and his unexpected ally had assembled a one-man balloon and attached it to the rope bridge. Teal wrestled with a cluster of alcohol burners, directing heated air into the leather envelope's brown gloom.

At last the envelope rose from the frozen earth, billowing like a waking giant. Orange strained to hold it back; she trumpeted in alarm as she was dragged across the ground. Teal pulled a harness round his shoulders.

There was a gust of wind. The balloon lurched higher and its guide ropes began to scrape up the rope bridge.

The harness dug into Teal's armpits. His feet left the ground.

Orange fell away, her huge head rotating up to him. Soon the anchor shrank to a cluster of bundles, anonymous in the gray landscape.

He wriggled in the harness, swinging slowly beneath the envelope. He looked to the south and picked out his home village. It looked like a muddy patch sprinkled with teepees... and out of one of the teepees came a running figure, shouting like an angry insect.

Damen, his brother. It had to be. Well, Teal couldn't be stopped now.

He continued to rise and Damen's cries dropped away. Soon there was only the creak of the rigging, his own rapid

breath.

The barren landscape opened out further. It was a dreary panorama of red and gray, starved of color and warmth by the dying Sun. His grandmother spoke of flowers a bright orange, birds as blue as ice -- of hundreds or thousands of people in villages clustered so close they were forced to fight over resources.

But now colors like *blue* were only a dim childhood memory to Teal. And there were only a few score people in Teal's village, and no one knew how far away their nearest surviving neighbors were.

The low clouds fell on him; the world shrank to a fluffy cocoon. Flecks of snow pattered into his face, and he drew the hood of his leather jacket tight around his head.

Then he burst into crimson sunlight.

He gasped at the sudden clarity of the air. Frost sparkled over his cheeks.

The rope bridge rose from the carpet of cloud below him and arced gracefully across the Gap, a spider's web between the twin worlds. Finally, on the other side of the Gap, it disappeared into a second layer of broken cloud... a layer belonging to another world, upside down and far above him.

The landscape of the world above -- called Home -- served Teal's world -- called the Shell -- as a sky; it was an unbroken ceiling coated with upside-down seas, rivers, forests, ice caps. Teal searched for familiar features. There were threads of smoke: fires warding off the chill, even at noon.

There was a sound behind him like the breath of a huge animal.

He twisted around and stabilized -- and found his eyes filled with orange light.

The Gap between Shell and Home was unbroken. The two worlds' darkling daylight was begrudged them by a

Sun, a mottled sphere a mile across -- a sphere that now twisted and rolled through the sky towards Teal...

...But it was going to pass miles above him.

Cursing, Teal labored at his burners. The balloon yanked him upwards, but soon the harness's pressure began to ease. He was approaching the middle of the Gap: the place halfway between the worlds where weight disappeared. He knew that if he continued his ascent, "up" would become "down"; Home would turn from a roof to a floor, and the place where Teal had been born would once more become the Shell over Home, the world that his grandmother's mother had known.

The Sun's breath became a roar.

He used a soaked cloth to dampen the burners, trying to hover just below the zone of complete weightlessness. The guide rope creaked; the balloon bobbed in a gust hot enough to scour the frost from his face, and he turned to the Sun once more.

It came at him like a fist. Boiling air fled its surface. His craft tossed like a toy. His eyes dried like meat in a fire and he felt his face shrivel and crack.

The guide rope snapped with a smell of charred leather. His balloon flipped backwards once, twice, seams popping. He roared out his frustration at the impossible thing--

Then the balloon was falling. He caught one last glimpse of the Sun as it passed above him, splinters of ruddy light stabbing through slits in the battered envelope.

He fell back through the clouds. Snow battered his scorched face as he labored at the burners, striving to replace the hot air leaking out of the envelope.

Soon he could make out the bridge anchor site, now surrounded by fallen miles of rope. There was patient Orange running in little agitated circles, and a bearded man standing there hands on hips, shouting something -- Damen, it must be -- and now Damen was running towards the point he would hit, a mile or so from the anchor.



The ground blurred towards him. He closed his eyes and tried to hang like a doll, soft and boneless.

The earth was frozen and impossibly hard. It seemed to slam upwards and carry him into the sky, sweeping up the wreckage of his balloon.

Damen carried Teal to his teepee and dumped him onto a pallet. Erwal ran to them and stroked Teal's face.

Overwhelmed with guilt Teal tried to speak -- but could only groan as broken things in his chest moved against each other.

Damen's bearded face was a mask of contempt. "Why? You useless bloody fool, why?"

Something bubbled in Teal's throat. "I... I was trying to fix..."

Damen's face twisted, and he lashed the back of his hand upwards into his brother's chin. Teal's back arched. Erwal tugged at Damen's arm.

Damen turned away. He walked with Erwal to the teepee's open entrance, speaking softly. He cupped her cheek in his massive hand... and then ducked out of the teepee. Erwal tied up the flap behind him.

"Erwal... I..."

"Don't talk." Her voice was harsh with crying. She bathed his face.

He closed his eyes.

When he woke it was night. His grandmother was watching over him, her face a wrinkled mask of reassurance in the alcohol lamp's smoky light.

"How are you?"

Teal probed, wincing, at his ribs. "Still here. Where's Damen?"

Allel rested a birdlike hand on his shoulder. "Not here. Take it easy." She laughed softly. "What a pair. You, the hopeless dreamer... just like I was at your age. And Damen

reminds me of my mother. A hard-headed, practical, obstinate -- so-and-so."

The old woman's quaint Home accent was like balm to Teal. He struggled to sit up; Allel arranged the blanket of soft leather over Teal's bound-up ribs. "You're not too badly hurt," she said. "Just a bit flattened. Your wife's left you some broth: boiled-up mummy-cow meat buds. See? Come on, let me feed you."

"Thanks..."

Allel pulled a stone knife from her belt. She'd owned that knife all Teal's life; Teal knew it was one of the few remembrances Allel had brought with her on her last journey from her home world. Now she used the blunt edge of the knife to ladle broth into Teal's cracked mouth.

"She worries about you, you know. Erwal."

Teal nodded ruefully through the food.

"Not good for her in her condition." Allel's voice was as dry as a rustle of leaves.

"I know. But I had to go, you know, grandmother. I had to try--"

"To save the world?" The old woman smiled, not unkindly. "Yes, just like I was... or," she continued, "perhaps you are a bit tougher. I crossed the Gap with my mother -- that was adventure enough -- but I'd never have dreamed of challenging the Sun itself..."

Allel's rheumy eyes peered into the wavering light of a lamp. "There are so many differences between Home and Shell. We had no mummy-cows to feed us, you know. Only cow-trees. And we spoke a different language. It took me long enough to learn yours, I can tell you, and my mother wouldn't even try..."

"I wonder if all these differences were intended, somehow. Perhaps the Sun was meant to fail. Perhaps there's a plan to force us to cross the Gap, to mix our blood and toughen ourselves--"

Teal pushed away the knife and lay back on his rustling pallet. He'd heard all this before. "Maybe, but such speculation won't help us find a way out of the trap the world's become. Will it?"

Allel shrugged mildly. "Perhaps not. But the alternative is ignorance -- which can only drive you to spectacular suicide. Such as by crashing into the Sun in a leather balloon."

Teal found himself blushing under his blisters.

"Before you can find a way out of the world you need to understand its nature." She wagged a bony finger. "Are you prepared to be a little patient, and do a bit of thinking?"

Teal smiled and propped himself up on one elbow.

Allel put aside the bowl of broth and settled herself onto a mat beside the pallet, cross-legged. "When I wasn't much younger than you, my mother took me on a long walk to an old abandoned City to the north of Home. And there I learned something of the nature of our world.

"The world is a box. We locked ourselves into a huge box to escape from the Xeelee, whatever *they* are. But the *nature* of this box is quite remarkable."

Teal gathered the blanket tighter around his aching chest. "Go on."

Allel pulled up a section of the leather mat beneath her and bunched it into a rough globe. "Here's a model of the world. Let's imagine there are insects living on this globe." Her fingers trotted comically over the globe; Teal smiled. "They're perfectly happy in their little world, never imagining the mysteries above or below them. Yes?"

"Now. I think the world we came from is a flat place, somewhere... else. Just like the rest of this mat -- a flat place that goes on forever, and contains stars and Xeelee."

She pointed at the place where the globe joined the mat, encased in her spidery fist. "The worlds must touch, as these models do here. We have to find such a place. A place

where you can walk out of our world and into the original... a door to fold through."

Teal nodded slowly. "Yes -- yes, I understand. But where would such a door be?"

"Ah." Allel smoothed the mat and stretched her withered legs. "That's the question. Surely it could only be in one of the old Cities, at the northern extremes of the worlds... But nobody on either world knows of anything that sounds remotely like a door. No human, anyway."

Allel dropped her eyes, wrinkles clustering around her mouth. "And there's another question. Sometimes I think it would be better *not* to find the door. There's so much we don't know about the past. Why not? Suppose it's been deliberately forgotten. Suppose we shouldn't try to find out about the world, the Xeelee... about ourselves. Perhaps it's better not to know--"

But Teal wasn't listening. "What did you mean, 'no human'?"

Allel smiled at Teal. "Nobody here pays much attention to mummy-cows, you know. They're taken for granted... just walking meat and milk dispensers, a source of muscle power... but they were a real novelty to me when I arrived. And I've spent a lot of my time listening to their songs."

"But mummy-cows are so simple."

"Maybe. But they're almost as old as mankind. No? And they've remembered some things we seem to have forgotten."

Teal grabbed his grandmother's arm, forgetting his pain. "Do they say where the door is? Tell me."

"Not quite. Take it easy, now. But... there is a song about a place, somewhere to the north of this world. A place called the Eight Rooms.

"Seven of those rooms are strange enough, the song says. And when you've found your way through them to the Eighth--"

"What? What's in the Eighth?"

Allel's grooved face was neutral.

Teal found his mouth gaping. "I've got to go there," he said. "That's what you're telling me, isn't it? I have to find these Eight Rooms." He pushed back the blanket.

Allel's thin hands fluttered against Teal's shoulders. "Now, not so fast. You're not going anywhere for a while--"

"Or ever."

Allel jumped. The new voice was flat and harsh; a massive figure swathed in quilted leather stood over Teal's bunk.

"Damen." Teal subsided back with a sinking heart. "How long have you been in here? How much did you hear?"

"Enough. I'm surprised you didn't notice me coming in; I nearly blew the damn lamps out." Damen's bearded face was full of stern concern. "Grandmother, you should be ashamed, pumping his head full of this rubbish. Brother, I'm telling you now you're not leaving this village again. Not ever; not while I'm alive -- not unless you get yourself exiled, anyway..."

"Damn it, man, Erwal's a good woman." His voice grew soft with unconscious envy. "Yes, a good woman. And she's bearing your kid. You can't go chasing sunbeams anymore."

Allel wiped off her stone knife and began picking at her fingernails.

Damen squeezed his brother's shoulder with his great mat of a hand. "You just work at getting healthy." He stood straight and walked to the teepee flap. "I'm sorry to be so tough, little brother," he said awkwardly, "but it's for your own good." He pulled the flap closed behind him.

Allel cackled sardonically. "Now, where have I heard that before? People always mean so well... but we go nowhere, while the ice closes all around us."

Teal lay back and stared at the darkness beyond the teepee's chimney flue. "So that's it. Damen will never let

me out of here." A despair as complete as the world's roof settled over him. "It's over, then."

"Not necessarily." Allel's voice was muffled.

Teal turned -- and then began struggling off the pallet. "Grandmother, what have you done?"

The stone knife lay on the mat, streaked with blood. A great gash opened Allel's face from temple to throat. The old woman swayed slightly, blood pooling around her neck. "Take the knife," she said hoarsely. "I'll say it was you."

"But..."

"In my mother's day, they'd have killed you for this, you know? But now, as times have grown harsher, we've had to work out laws to control each other. So they'll be civilized... They'll exile you. Just like Damen said. You can go where you want."

"But--"

"No buts. I'll make sure Erwal is cared for." She slumped forward. "Take the knife," she whispered. "Do it."

Involuntarily, she cried out. Blood looped over her mouth.

Outside the teepee there were running footsteps, lamps, shouts. Teal struggled across the mat and put his arm around the thin shoulders...

...and grasped the knife.

They let him recover from his balloon fall. They gave him a suit of quilted leather, containers for water, flints, a coil of rope... they didn't want to think they were sending him to his death.

Although, of course, that was exactly what they were doing.

On his last night Erwal came to his guarded teepee. She pressed a bundle wrapped in skin into his hands -- and then spat in his face, and hurried away.

Teal was twenty years old. He felt something soft dying inside him.

Inside the skin was his grandmother's knife, cleaned of blood. Teal tucked it into his belt and tried to sleep.

At dawn, most of the village turned out to watch him leave. Teal stared at the slack faces, the children with limbs like twigs, and beyond them the huddle of shabby little teepees, the piles of lichen, a half-butchered mummy-cow carcass. *Once, he thought, we could build worlds. We even built this boxworld. Now: now, look at us.*

There was no sign of Damen, or Erwal, or Allel.

Teal turned away, pulling his hood closed against the cold.

His feet were already aching by the time he passed the bridge anchor. There'd been no will to rebuild the world-bridge, and the rope lay crumpled amid the frost.

He felt as if he were walking through a great ill-lit room. Dead heather crumbled beneath his feet, gray in the ruddy gloom. Home, above him, was a mirrored roof as bleak as the ground beneath him.

Wind sprawled across the flat landscape. He walked until his legs were numb with fatigue.

When night fell he huddled beneath a shriveled cow-tree and sucked sour milk from its bark nipples. Then he buried himself in a rough bed of leaves, clutching the stone knife to his chest and determining to think of nothing until dawn.

There was a rustle under the wind. A warm breath, not unpleasantly scented--

He snapped awake and scrambled backwards out of his nest. In the starless gloom a huge shape hovered uncertainly.

He held out the knife with both hands. "Who is it?"

The voice was ill-formed, soft, and infinitely reassuring. "It iss me... Orange. I am so-ssorry to wake you..."

Teal let out a deep breath and lowered the knife. He found himself laughing softly, his eyes wet. How absurd.

Orange moved closer to the cow-tree, and Teal snuggled into her warm coat.

After that he slept for most of the night.

In the morning he breakfasted from the food teats clustered over Orange's lower body. There were milk and water nipples, and meat buds that could be snapped off, without discomfort to Orange.

They set off just after dawn, with Teal munching on a still warm bud. Orange wore a saddle-shaped pannier into which Teal loaded his meager possessions.

The morning was chill but comparatively bright, and Home was a shining carpet overhead. Teal felt his spirits lifting a little.

"Orange... why did you follow me?"

"Your gra-grandmother told me where you were going. So I decided to follow."

"Yes, but why?"

"To... help."

He smiled and wrapped a hand in the coarse hair behind her ear. "Well, I'm glad you're here."

That evening Orange used her articulated trunk to gather handfuls of moss. She packed his aching feet with it and then licked it off. "My... saliva has healing properties," she said.

Teal lay back against her fur. "Yes," he said. "Thank you..."

The reddening world folded away, and he slept.

They came to an abandoned City.

Teal walked through arches, into low cylindrical buildings. The walls were as smooth as skin and knife-thin, showing no signs of age. But the interiors were unlit and musty.

They walked on despondently.

"Did grandmother tell you what I'm trying to find?"



"Yess. The... Eight Roomss."

"The trouble is I've no idea how to get there... or even how we'll recognize it when we find it. We're walking at random."

Orange hissed, "From the ss-stories I have heard, you will... know it wh-when you ssee it..."

Teal looked at her carefully. Was there a trace of amusement in that clumsy voice?

"What stories? What are you talking about?"

But the huge round face was blank.

On the fifteenth day... or maybe the sixteenth... a blizzard hit them.

It was a moving wall that reached up to the clouds. It turned Teal's world to a blur of huge flakes; the air was almost unbreathable.

"We must... must keep moving," Orange trumpeted. He buried his face in her snow-laden fur. She wrapped her trunk around his shoulders. "F... follow me," she said. "We will find... the Eight Rooms..."

He closed his eyes and struggled on.

The storm took days to clear.

Teal woke to a world silenced by snow. Brushing clear his clothes, he sat up to look around.

Orange was staring straight ahead, her fingers working in agitation.

"Wha..." Teal squinted in the direction she was looking, to the red-lit north.

There was something on the horizon: a patch of darkness amid the snow.

A structure.

It was a cube with sides about half as tall again as a man. The walls were unbroken save for a single large door set in the south-facing side.

The whole thing was hovering about an arm's length from the ground.

"The s-songss," hissed the mummy-cow. "That iss what... the songs describe..."

"The Eight Rooms," Teal sighed. "You were right. It's unmistakable."

Orange quivered; he studied her curiously. She was paralyzed by fear... *but she'd known where to look*. He thought of generations of mummy-cows, used and despised by the people they'd been designed to serve -- but all the time hoarding a knowledge and lore, a kind of courage, of their own.

He wondered uneasily how much else there was to learn about the world.

He stumbled to his feet, then patted Orange's flank. "Come on," he said. "Just a bit further..."

Orange wouldn't come closer than a few paces to the structure. Teal approached alone. He knelt in the snow and passed his hand underneath the cube. "Must take an awful lot of hot air to hold this up..."

Teal walked up to the door and pushed tentatively. He found his chest tightening.

Orange whimpered and buried her eyes in her trunk.

He opened the door wide. The interior was pale blue.

Teal hadn't seen blue for a decade.

Blinking away tears, he climbed into the room.

They spent the night under cover for the first time since Teal's exile. He woke in comparative warmth and took a slow breakfast on water and a cheeselike bud.

It had taken a lot of coaxing to get Orange to clamber into the room.

"There's nothing to fear -- it's just a big teepee."

"No, it is-isn't..."

"Well, maybe not..."

Now she huddled uncomfortably at the center of the floor, standing in her own muddy footprints.

Teal inspected the room. He'd found it empty save for a thing like a lamp bracket attached to the ceiling. There were doors leading out from all four walls -- even hatches in the floor and ceiling.

The doors watched him like blank eyes.

He ran his hands over the blue walls. The material was warm, slightly yielding -- disconcertingly skinlike. He thought of stroking his wife's belly through a soft leather blanket.

He pushed the image away.

He took his coil of rope from Orange's pannier. He tied one end round his waist. "Here," he said. "Don't let go of this. If you don't hear from me... after a while, try to pull me back. Do you understand? And whatever happens, go back and tell my grandmother what you've seen. All right?"

The great head dipped. He stroked her trunk, once.

He turned to the door opposite the entrance to the cube. Orange shivered as she watched him. *Now then*, he thought, *logic tells me there's nothing beyond this door. Only another way out, to the snow.*

*Right?*

He pushed at the door. It swung back smooth as a muscle.

There was another room beyond. It was like a mirror-image of the first: bare walls, single light pendant, doors all over it--

Maybe it really was a reflection.

No, that was stupid. He looked back at the trembling brown hulk of Orange. There was no Orange in the second room... and no Teal, for that matter.

He stepped through the door.

Well, the floor felt solid enough... and the air was just -- air.

All his intuition told him he should have been hovering at waist-height somewhere outside the boxlike structure. Instead, here he was...

He laughed. So Allel's old song had been wrong. The wonder of the second room wasn't in what it contained, but in the fact that it was there at all.

Pulling the rope of twisted leather behind him he pushed at the door in the left-hand wall of the second room. Beyond was a third room, another copy of the first.

He decided he wasn't surprised.

More confidently he walked through the third room and pushed at the door to his left. Beyond this he'd presumably find a fourth room, making up a square array of rooms, and then he could turn left again to find his way round the square back to Orange--

The fourth room wasn't empty. It contained Orange. He was looking at her left side; she held a grubby rope that stretched forward through an open door.

She turned her head to him, eyes wide with astonishment.

He jumped back, trembling. Could he have miscounted the rooms?

His mind racing, he took Allel's knife from his belt and placed it gently on the floor inside Orange's room. Then he walked back through the third and second rooms.

In the first room, Orange was facing him. "Take it easy," he murmured abstractedly to her. "It's all right..."

The door to her left was ajar. A stone knife lay on the floor, just inside the first room. He walked across to pick it up, tucked it into his belt.

Well, it felt real. Were there two knives now?

He walked around to the third room again. The knife beyond the door was gone... of course.

So there was no fourth room to make up the square.

He sat on the bare floor of the third room and closed his eyes. If he wasn't careful, the strangeness of the place was

going to overwhelm him.

He opened his eyes. He looked speculatively up at the hatch set in the ceiling of the third room. Surely he would break out of this odd cycle if he climbed up another level.

He stood up straight. The lamp fitting was just out of his reach, but he found that if he -- jumped -- he could just grab it with both hands.

He hung there for a moment, gently swinging, the burn scars around his chest itching slightly. Then he arced backwards, swung both feet forwards and slammed them into the roof hatch.

It fell back with a soft thump. Another swing, one-armed this time, and Teal had grabbed the edge of the hatch-frame. Then it was simple to haul himself up into the room. Orange's rope trailed after him.

The fourth room was empty -- another copy of the first, with the usual lamp fitting and the six exits. He took a few deep breaths and let his heart rattle to rest; and then, with a kind of confidence -- surely there was nothing else that could be thrown at him -- he strode forward and pushed open a door.

He almost cried out.

Through the door in the wall he was looking into the first room again -- but the whole room was tipped on its side. Orange looked as if she was clinging to a wall, a huge hairy spider. A rope trailed from her trunk out of a door ahead of her.

He shoved the door closed hastily, fighting back a sudden wave of nausea. Suppose he'd stepped forward... surely *sideways* would suddenly have become *down*, and he would have fallen full-length onto poor Orange. And if she'd looked up as he stood there, would she have seen him sticking sideways out into the air like an outstretched arm?

He didn't even try to work out the explanation this time. With some reluctance he turned and walked across to the

door opposite Orange's. What next? Unconsciously he pulled his stone knife from his belt.

He opened the door.

It was the Eighth Room.

For the first time in a hundred thousand generations, starlight entered human eyes.

Orange had no way of telling the time.

She couldn't even count well enough to keep track of her thumping heartbeats. Holding her rope she hummed a song to herself.

She sang it over and over, ever faster.

The rope had been slack for too long now, surely. Trembling, she shuffled to the open door and fanned out one great ear.

Silence.

Was he dead?

Her hands slipping in anxiety, she began to pull the rope towards her. There was a weight at the end that moved unevenly--

-- and then there was a bump and a slackening of the rope, as if the weight had fallen a considerable distance.

She waited, urging the silence to yield up its secrets. But she didn't dare go beyond that door.

She began hauling at the rope again. Now it moved easily. At last Teal's limp form came through the door, still clutching his grandmother's knife.

His eyes were open. They stared through her, and the walls, at... something that made her shiver.

She gathered him to the warmth of her underbelly and bathed his face with antiseptic saliva, longing for him to wake.

She waited in the alien place for days.

Teal's breath was even but his eyes never flickered. Hunger growled in her own belly. Soon she wouldn't even

be able to feed him...

Finally she wrapped his face in his hood and, with difficulty, loaded the man and his tools over her broad back. With her delicate fingers she pried open the entrance.

She emerged into a blizzard.

Keeping her trunk arched back over her precious cargo she battered her way through the storm, stumbling as her great stumps of legs buried themselves in drifts and slurries.

The blizzard wouldn't stop. She found she couldn't even detect the passing of night and day.

Finally she sank to her knees, exhausted. She lowered Teal to the snow. His lips were gray.

Snowflakes like flat stones battered unnoticed at her huge eyes. So she had failed, and Teal would die...

She raised her trunk and bellowed out her defiance. Then she searched among Teal's effects for his stone knife.

Standing away from Teal, she held the knife in both her hands, point towards her, and worked her fingers around the handle.

Then she jerked the point backwards into her chest and ripped it down her underbelly, as far as she could reach.

The pain was astonishing. It didn't seem fair.

She dropped the knife and wrapped her hands around the slit flesh. Then she shuffled towards Teal, leaving a streak like a bloody snail.

She covered him with her ripped body, let the soft stuff inside gush over him. With the last of her strength she held her head high, to make sure all of Teal was tucked inside her. Then she let go. Her head slumped forward, and now the snow was as soothing as her mother's trunk had once been.

Her body had been designed, from the cellular level up, to serve humans; and now, she knew, it was performing one last miracle. Oxygen-bearing blood would bathe the

shocked man like amniotic fluid, while her internal organs, now independent semi-sentient creatures, would cluster round him in this ultimate emergency and cradle him against the cold for as long as he needed.

She felt her thoughts break up and crumble.

Her mother came towards her across the snow. She was carrying a Sun on her back, but it wasn't orange, old, failing like the real Sun. It was yellow, and it melted the snow.

Allel heard the shouting from the gloom of her teepee.

Nobody shouted these days. With the Sun never brighter than the twilights of her youth, there wasn't much to shout about.

Except...

She unhinged her stiff old legs and rose from her leather mat. Outside, Home was a bloodstained raft floating over the landscape. The Sun was bright enough to sting her watery eyes, and the breeze pricked at the scar bisecting her face.

All the excitement was at the north of the little settlement. She saw her grandson Damen standing there, massive and obstructive. A few other villagers were walking towards Damen, dull curiosity brightening their drab faces.

Someone brushed past Allel: Erwal, Teal's wife. When she realized what was happening Erwal began to run.

It was him. It had to be. He'd survived, and returned. Allel hobbled over the icy mud.

Damen heard Erwal coming. He turned and spread his arms to catch her. "No! Ignore him. Don't hurt yourself anymore..."

Beyond them a silent figure stood alone. Allel squinted, but found it hard to make out a face.

Erwal shook her small fist. "Keep away from here. Keep away! I lost my baby because of the hurt you caused me,



you... madman. Keep away from me." Then, deliberately, she pulled Damen's head down towards her and kissed him full on the lips. Teal watched this with no sign of emotion.

Damen wrapped his arm round Erwal's shoulder and turned to Teal. "You'll have to stay away, brother," he said sadly. "There's nothing for you here. You're an exile."

Allel came alongside Damen, gasping with the exertion. It was the furthest she'd walked from her teepee since her injury. "Why?" she asked. "Why bother, Damen? He's lost his family already -- lost everything. What more can you do to him?" She looked around at the dozen or so villagers clustered around them. They were an array of shabby indifference, their eyes large and slack in malnourished faces. A baby cried feebly at its mother's shriveled breast. "We're at the end of things. Who cares anymore?"

Damen frowned doubtfully. Then he turned and led Erwal away.

The other villagers drifted back to their chores.

Allel was left alone.

In the gathering darkness Teal was obscure... changed. Allel walked towards him, wrapping her skinny arms around herself.

"Tell me what you saw. Tell me what was in the Eighth Room."

Teal smiled.

The far wall of the Eighth Room had been a great window, he said. He'd stepped cautiously through the door -- and then the other sides of the cubical room had faded to clarity.

Dressed in skins, and brandishing a stone weapon, a human being once more stared out of a cave at the stars.

The stars were points of light unimaginably far away... much further than the distance between Shell and Home. He turned around and around, stepping over the rope that

led back to Orange. There was no sign of the world he'd folded out of; the crystal box was suspended in space.

Gradually he began to make out patterns.

There was a great ball of stars over there on the right, neat as a mummy-cow's meat pod -- but he guessed that this star pod was bigger than a million of his worlds. Above his head there were fragments of a cubical lattice, draped with wisps of violet gas... and behind him, most spectacular of all, a sextet of varicolored stars that rotated visibly around an empty center. Great arches of fire leapt between the sisters' surfaces.

There were loops of stars, knots of stars, stars in sheets like the cloaks of a god.

He remembered Allel describing the stars in the old days, randomly scattered like seeds. Well, since humans had hidden away, someone had rebuilt the Universe.

...Something moved past the stars. And again--

Nameless objects, black as night, were moving around him. They stroked at this fragile container like the hands of a huge parent.

He felt no threat. There was a sense of reassurance, of welcome, in their gestures.

*I was meant to be here, he realized abruptly. Allel was right: the world is freezing by design. It spat me out, and these creatures have been waiting for me.*

The half-dozen shapes now drew away from his box and gathered together in a great blur transiting the stars. They moved past and through each other, ever faster, weaving themselves into a tight knot of darkness--

-- and then, in a sprinkle of prismatic light, they shot away to... somewhere else.

They'd finished with the Universe, abandoned it. But they'd left something behind.

It was a ship. It nuzzled against his box, a great shell big enough to hold his village and a hundred more. The

Universe would be his.

The stars began to spin like sparks in a fire. They tilted, overwhelming him.

His next memory was of crawling out of the corpse of the mummy-cow.

Allel shifted her weight between her stiff legs. "Xeelee ships," she croaked. "That's what you saw. Ships like plucking fingers." She coughed feebly, feeling the cold of the dying day sink into her flesh. "Listen. I know what you've sacrificed to do this. I know you've lost everything important to you... But, Teal, you've saved us all."

She reached out a hand to her grandson.

Teal didn't react. Allel dropped the hand nervously.

"You knew what I'd find, didn't you?" Teal asked coolly. "You suspected the truth of our history -- the completeness of our defeat by the Xeelee."

Allel sighed, and folded her arms over her concave chest. "Yes. The truth about the past has been hidden from us so long and so well that it had to be painful. The story I learned when I was young was comforting: the Xeelee as marauding monsters bent on destroying us; our valiant fight and honorable defeat. A comforting myth.

"I've thought hard about that story... and seen past it to the truth.

"We were a weak and foolish race. We attacked the Xeelee, unable to bear their superiority. We were defeated. But we would have kept on attacking them until we were destroyed.

"And so the Xeelee locked us away like destructive children... for our own good. Just like an elder brother, eh? It's not easy to accept."

"No, it isn't," Teal murmured. "We didn't build this world to save us from the Xeelee. The Xeelee built it to save us from ourselves."

Allel studied his empty face. She thought of seeing the stars: of waking in a place without a roof over the world.

But, of course, the frozen lands to the north made the stars as unattainable for her as her own lost youth.

"Well." She wiped dampness from her eyes. "Come to my teepee. I've got food. And blankets."

She turned and began to hobble back to her home.

There was a transparent box, half as tall again as a man. It hung in space, in orbit around a cooling white dwarf star, apparently forgotten and purposeless. It would have had no conceivable significance in the long twilight of the Universe... if it had not occupied the site of Earth, the long-vanished original home of man, long consumed by its own sun.

A Qax had once visited the site. It was puzzled. The box was evidently one three-dimensional facet of a hypercube, extending into folded space. Perhaps it was a gateway, an interface to some pocket Universe. Such things had been constructed by the Xeelee elsewhere in the Galaxy.

But why here, in the ruined cradle of humanity?

The Qax had placed quantum-inseparability markers around the box. The Qax were linked to the markers by single quantum wave functions, ghostly threads that stretched across light years, and they had scattered millions of markers over the spaces once inhabited by humans.

At last the human called Teal walked into the box. He stared, openmouthed, at the stars. He was gaunt, filthy, and dressed in treated tree-bark; a rope tied to his waist snaked around a corner and into another Universe. After some time the rope grew taut and Teal's limp form was hauled away.

The inseparability markers blared their warnings. A Qax hauled itself like a spider along the quantum web to the box

-- but it arrived too late; the box was empty. The Qax hissed, settling into space like condensing mist.

With a patience born of millions of years it prepared to wait a little longer.

The event spread like a soft blue dye through the linked quantum phenomena which comprised Paul's being. At the site of Earth there was a human once more: but a human alone, weak, tired, close to dissolution. Paul, godlike, pondered the implications for an unimaginable interval.

Then he came to a decision. He reconstructed his awareness; a quantum jewel danced against the clear walls of the Eighth Room.

History had resumed.

*"Allel was right," I said. "The defeat, the imprisonment, by the Xeelee was complete. Unbearably so. What a humiliating scenario."*

*"Perhaps. Humans as Eloi, to the Xeelee's Morlocks."*

*"...Eloi?"*

*"Never mind. Another prophecy, much older than mine..."*

*Inside the hypersphere cage, the human story seemed over. But the rhythms of life persisted, and with them the unwelcome urge to survive...*

# **The Baryonic Lords**

**A.D. 4,101,284**

Erwal pushed out the greased flap of the teepee. Hot, humid air gushed into the blizzard, turning instantly into fog.

Damen, dozing, grunted and burrowed more deeply into his pile of furs.

Erwal pulled her mummy-cow furs more tightly around her neck and stepped out into the snow -- it had drifted some three feet deep against the teepee's walls -- and smoothed closed the flap. Clutching her slop pail she looked about in bewilderment. The world seemed to have collapsed to a small, gray sphere around her; rarely before had she seen snow so heavy. The flakes clung to her eyelids and already she could feel the down on her upper lip becoming stiff with cold. Dropping her head she began her struggle through the blizzard.

Somewhere above the clouds, she thought wistfully, was the Sun, still winding through its increasingly meaningless spiral between the worlds.

Already the snow had soaked through her leggings and was beginning to freeze against her skin. With a sense of urgency she forced her legs through the snow, dragging the slop pail behind her. Soon she was out of sight of the teepee; the rest of the village remained hidden by walls of snow, so that she had to make her way by memory alone.

At last she reached the village's central stand of cow-trees. She leaned against a tree for a few minutes, sucking at air that seemed thick with the snow. Then she began to dig with her bare hands into the drifts at the base of the tree, finally exposing hard, brown earth. She dumped the

contents of her slop pail against the roots of the cow-tree and stamped the waste firmly down against the wood. Then, wearily, she straightened up and began to select some of the tree's more mature buds, filling her pockets. The meat buds were small, hard, anemic; she bit into one, tasting sourness.

A villager approached through the storm. At first Erwal made out only a blur of rags against the snow, but the villager noticed Erwal and leaned into the wind, making towards her.

Erwal shouted: "Good day!"

From within a voluminous hood there came a muffled, brittle laugh; then the hood was pushed back to reveal the thin, pretty features of Sura, wife of Borst. "It's hardly that, Erwal." Sura had dragged her own slop pail across the drifts; now she dumped her waste alongside Erwal's. As she worked Sura's shapeless fur blanket fell open and Erwal made out a bundle suspended over her thin chest, a sling of skin from which protruded tiny hands, a small, bare leg. Erwal frowned; the baby's exposed flesh seemed blue-tinged.

Once Sura had finished Erwal held her head close to the girl's. "How are you, Sura? How are your family?"

"Borst is ill." Sura smiled, her eyes oddly bright. "His lungs will not clear; he has been barely able to stand." Absently she patted the bundle against her chest.

"Sura, will you let me visit your teepee? At home there is only myself and Damen..."

"Thanks, my friend, but I'm sure I can manage." Again that bright look entered the girl's pale eyes and she brushed a wisp of hair back from a high forehead. "The child is a burden, but she's such a comfort."

"I'm sure she is," Erwal said evenly. The pain of her own lost child -- stillborn soon after Teal's first mysterious voyage away from the village -- was too long ago to mean anything now, and the dismal fact that she and Damen had

proven unable to bear another child had come to seem trivial compared to the huge, greater tragedy sweeping down over their little community.

"How is the baby? Will you allow me?..." Erwal opened Sura's blanket just a few inches, tenting the flaps so that the snow was kept from the child, and ran her fingers over the hot bundle. Sura looked on, a vacant smile hovering about her mouth. The child's breathing was rapid, ragged; the tiny hands were as if carved from ice. "Sura, you must take the child indoors. Keep her covered. I am afraid her limbs are frozen--"

"She needs air," Sura said, her voice high. "It's so musty in the teepee."

Erwal stared into Sura's eyes. Her skin was smooth but her eyes were ringed with dark shadows. Sura was little more than a child herself. "Sura," Erwal said urgently, "you aren't thinking clearly. The child is too cold."

The shallow smile evaporated. Sura brushed Erwal's hands away resentfully, and began to paw at the baby. "She'll be all right." She cupped one tiny hand in her own and began to rub vigorously.

"Sura, take care, I beg you."

"She just needs to get warm--"

There was a soft crackle, as if a thin crust of ice had broken.

It was a sound that Erwal knew she would remember to her dying day.

Sura's head jerked down; her jaw seemed to be swinging loose, the muscles in her cheeks slack. Erwal, watching in horror, felt as if she would faint; it was as if she saw the whole tableau, Sura, the child and the snow, from a great distance.

Sura opened the hands which had cupped the child's. Detached fingers lay like tiny jewels on Sura's callused flesh. The child whimpered, stirred against its mother. Sura jerked her hands back, so that the frozen pieces of flesh fell



to the snow. She pulled her blanket tight around her and ran, oblivious to the drifting snow.

Erwal bent and scooped up the tiny fingers, the fragments of palm and wrist.

When she returned to the teepee, Damen had woken. Wrapped in a blanket, he held a pot of water over the fire with wooden tongs, and he scowled at the draught Erwal made. The smoke from the fire, disturbed, swirled around the teepee walls in search of the vent at the apex.

Erwal, wrapped in her furs, felt like something inhuman, a gigantic animal intruding into this place of warmth. She pushed away the furs, hauled off her frozen leggings and huddled near the fire; Damen wrapped a heavy arm around her until the shivering stopped. When the water boiled Damen poured it over fragments of mummy-tree bark. Erwal sucked at the thin, steaming tea.

Then she opened her hand.

Damen picked up one tiny finger. His face gray, he studied the tiny nail, the knuckle's bloodless termination. Then he took the rest of the fragments from Erwal and dropped them into the fire. "Whose child?"

"Borst and Sura; I met her at the tree stand with her slops. I have to go to her, Damen."

"Do you want me to come?"

"...No. It's best if I go alone, I think. You keep the teepee warm." She drank her tea, deeply reluctant to don her furs once more. "Damen, we can't go on like this. Every year is worse than the last. I suspect the trees are starting to die, and even the mummy-cows aren't immortal."

"I know, love. But what can we do? We have to survive until the Sun recovers, and then--"

"But what if it doesn't recover? It's been failing since your grandmother's day. Allel told us so herself. And now -- Damen, it's only early autumn, but the blizzard out there is blind; if we're not careful the teepees could be snowed over

before the winter's out." She shivered, imagining tiny pockets of warmth lost in the snow, the humans within suffocating, cooling, calling to each other.

"The Sun will recover," Damen said wearily.

She said urgently, "But we don't have to wait here to die. Teal said--"

"No." He shook his massive head, his gray beard scraping over his chest.

"But he told us there was a way out of here," she insisted. "The Eight Rooms. He found them, saw them. Your grandmother believed him."

"Allel was a foolish old woman."

"And Teal returned there. He said he'd leave a trail for the rest of us. Maybe if--"

He wrapped both arms around her. "Erwal, my brother was crazy. He hurt you, fought with me... He lost his life for nothing But now it's over. He's gone, and--"

"What if he survived?"

"Erwal..."

She sighed, pulled herself away from him, and began to haul her leggings over her still-cold feet.

Damen sat in silence, staring at the fire.

As she pushed through the snow Erwal heard odd snatches of song. The melodies, soft, harmonized and sad, were fragmented by the wind, and at first she thought she was dreaming. Then Sura's teepee loomed out of the snow. Before it she made out a series of low mounds about as tall as she was. Occasionally a trunk would lift out of a mound, the two very human hands at its bifurcated tip twisting together, and slowly the songs grew clearer.

At last Erwal recognized the ancient chants of the mummy-cows.

Five cows, almost the village's full complement, were grouped in a tight circle about a sixth; the latter lay at the center of the circle, and Erwal saw that some viscous fluid

had leaked from its bulk into the snow. She pushed back her hood. "Sand? Are you here?"

One of the mummy-cows lifted her head; under a cap of snow a squat, cylindrical skull rotated on a neck joint and plate-sized eyes fixed on Erwal. "...I amm-m hhere, Err-waal..."

Erwal fixed her fingers in the shaggy fur covering Sand's muzzle. Since Erwal's childhood, Sand had been her favorite. "What's wrong? Why are you gathered here?"

Sand moaned and scuffed with delicate fingers at the snow before her. "It iss-s Cale. We are... s-singing for her..."

"Singing? But why?..."

Sand closed her eyes.

Erwal turned to inspect the body at the center of the group. Cale was silent, utterly motionless, and when Erwal pushed her fingers through the fur she felt only a diminishing warmth.

How could this have happened? The mummy-cows rarely reproduced these days -- there was too little fodder for them to generate the growth required -- but they were virtually immortal. She walked around the fallen cow to the patch of moisture she had noticed earlier. She bent and touched the stuff. It was blood. Crouching, she probed upwards at the mummy-cow's belly, exploring the soaked and matted fur. There was a tear in the flesh, a gash at least two feet long that was sharp and clean; performed by a stone knife.

She took deep breaths of the chill air; then she forced herself to reach forward, lift aside the flap of cut flesh, push her hands into the glistening stuff inside the cow.

She found a still, cold form. Snakelike entrails had coiled around the body in a hopeless attempt to keep it warm. Exploring by touch, Erwal found the tiny buds, hard as gristle, which had begun to grow to replace the child's lost hands.

"She's dead, isn't she?"

Erwal withdrew her arms, rubbed snow over them to clean them, tucked them once more into her clothes. Sura stood beside her, her arms loose at her side. "...Yes, Sura. I'm sorry."

"It worked for your husband, didn't it? Teal, I mean. That mummy-cow he took to the Eight Rooms kept him alive by opening herself up... I suppose you despise me because I have killed a cow." Sura sounded resigned, no longer caring. "Will you punish me?"

Erwal stood. "No, Sura. I understand."

"You do?"

"You were trying to save your child. What more can any of us do? What else is there? Come on." She took Sura's unresisting arm. "Let's go to your teepee."

"Yes," Sura said.

On the first clear day of the tepid spring the villagers filed in silence to a low hill a mile from the village. After months in the fug of the teepees Erwal took deep breaths of the cold, fresh air, and felt the blood stir within her. She looked around with renewed interest. It was a still, windless day; above her the lakes and rivers of Home shone like threads in a carpet. The ruddy light of the Sun was almost cheerful, and frosty snow crackled beneath her feet. She tried to imagine what it must have been like in the days before she was born, when the Sun was yellow and so hot that, even in spring, you could discard your furs and leggings and run like a child in some huge teepee.

At the top of the hill orange flowers were struggling to blossom through the permafrost. The villagers gathered in a rough circle around the flowers; some clasped their hands before them, others dropped their heads so their chins rested on their shirts of fur. Damen stepped into the middle of the circle. "We're here for those who died in the winter." His voice was flat and lifeless. Without ceremony he intoned a list of names.

"...Borst, husband of Sura. Brought down by fluid in the lungs. A girl, daughter of Borst and Sura; the frost attacked her flesh in the blizzards..."

Numbly Erwal counted the names. Twenty-two in all, mostly children. She glanced around the silent group; there were surely no more than a hundred souls left. Already, she knew, the outer portions of the village had been abandoned, so that their homes were encircled by silent, ruined teepees.

There were hardly any old people left, it struck her suddenly. In fact, she and Damen were the old people now. Who would be the last to go? she wondered morbidly. Some child, crying over the cooling bodies of its parents?

At that moment her resolution crystallized. With or without Damen, she had to leave this place.

Damen finished his list. After a brief, gloomy silence, the group broke up and returned to the teepees.

Twenty-five adults decided to commit to Erwal's plan. With their children, thirty-seven people would travel with her.

They gathered at the edge of the village. The split families and parting friends found little to say in the way of farewells. Erwal, with the assistance of Sura, made final adjustments to the harness around the neck of Sand, the one mummy-cow they were to take. To the harness was attached a broad pallet piled with furs, blankets and cow-tree buds. The rest of the expedition, spare clothes heaped on their bodies, looked on in subdued silence.

"I don't know what to say."

Erwal turned. Damen, thick arms folded, stood watching her. "Damen, don't even try."

He frowned. "Pride's an odd thing," he mused. "I should know. I've been proud, and stubborn. Pride can make it hard to admit you're wrong, no matter how misguided you come to realize--"

Erwal laughed, not unkindly. "I should swallow my pride, admit my mistake, should I?"

He looked hurt. "Erwal, you could die out there."

"But I believe we'd die here." She touched his arm, ruffling the mat of thick black hair which grew there. "This expedition needs you--"

"But I need you."

It was as if the Sun had broken through cloud. Struggling to keep her voice steady, Erwal said, "You've picked the damndest time to say such a thing."

"I'm sorry."

Deliberately, with a sense of pain, she turned her head from him. "It's time to go."

"Where?"

"You know where. To the north. The way Teal described. A journey of a few days, following his markers and directions, to the Eight Rooms."

He snorted. "Following the babble of a mummy-cow and a madman?"

"Damen, don't spoil this." She studied him, desperate to hold on to these final traces of warmth. "I know what I'm doing."

"I know. I'm sorry, Erwal; we've been over all of this before, haven't we?"

"A hundred times." She smiled.

"...I wish you well."

She hugged him, feeling the rough fur of his shirt under her bare forearms. "And I you, love."

"I won't see you again."

"...Perhaps if I find what I'm looking for I'll be able to return for you."

He held her away, his face hard. "Sure you will."

With that, they parted.

With gentle encouragement the mummy-cow began its lumbering motion, the laden pallet scoring tracks into the hard ground. Erwal walked arm in arm with Sura. She

turned back until the village was out of sight; for long after she was gone, she suspected, the dark bulk of Damen would be stationed at the edge of the village, hoping for her return.

A short, round-faced man called Arke walked with Erwal. "This winter," he said, "I lifted the body of my wife out of the teepee and into the snow. I had to wait for the thaw before I could bury her in the cow-tree stand. I barely know what you're talking about with your stories of stars and ships, Erwal, but I know this. If I'd stayed at home I'd surely have died. At least with you I'll die trying to find a way out. And," he finished doubtfully, "you never know; we might even succeed."

Many of her fellow travelers, Erwal suspected, had been motivated to come by much the same mixture of desperation and doubt; and yet they had come. And, as they walked, Erwal sensed a mood of optimism generated by the very fact of their motion, that they were doing something.

But winter came early in the north.

The winds hit them first, so that the children, wailing, were forced to stumble along clinging to the fur of the cow, who sang them simple songs. Then snow followed, and the march became a grim haul across a featureless plain punctuated by nights huddled in a single, shivering mound under a layer of blankets.

Erwal had memorized the list of directions which Teal had given to the village, and she was as sure as she could be that she was not leading her party astray. But on the more difficult days she was constantly aware that she was hardly equipped to serve as the leader of such an ambitious expedition; and when they entered the mouth of yet another blizzard she found tears leaking from her freezing eyes, and she wondered if she was guiding these people to their deaths.

Then, one day, Sura came pushing through the snow drifts. She grinned, excited, holding up a faded rag. Erwal, tired and bemused, pushed snow-speckled hair from her eyes and took the object from the girl. It was a strip of mummy-cow hide. Roughly cut and uncured, the strip had been frozen before it had a chance to rot; and it was tied with a double knot.

"Teal," Sura said. "This is one of his markers, isn't it? I found it tied to a dead cow-tree, just over that ridge."

Erwal stared at the battered little artifact. "Yes, it's Teal's. Call the others and tell them."

The find of the marker was treated as a great triumph, and the travelers drank Sand's milk with an air of celebration. They approached Erwal and touched her arms and shoulders, congratulating her. Erwal felt oddly distanced from all this. After all, they had only confirmed that they were on Teal's path -- a path which, as Damen had repeatedly pointed out, might lead only to madness or death.

But she kept such thoughts to herself and did her best to join in the celebrations.

After a rest, they struggled on into the teeth of the wind, making headway as best they could.

They made a makeshift camp in the heart of another blizzard. They burrowed together in the snow, faces buried in their furs.

In the dim morning light Erwal was shaken awake. Thick with sleep and unwilling to leave her warm nest she slowly opened her eyes. Sura was bending over her, her cheeks flushed under spots of frostbite. "Erwal, we're there!"

"What?"

"The Eight Rooms! It's just as Teal described. Come on!"

Erwal pushed her way out of the snow. Her knees and hips ached. All around her, people were emerging from their snow cocoons. She rubbed a little snow into her face,



then took a mouthful of the crumbling stuff and let it melt on her tongue.

For once it was a clear, still day. The snow lay in great mounds to the horizon, and the desolate landscape was punctuated only by the defiant remnants of cow-trees -- and, on the northern horizon, by a building. Erwal squinted, straining to see in the dim daylight. It was a large, plain box, just as Teal had described.

#### The Eight Rooms.

Her party began to make for the artifact. The children ran whooping, the adults hurrying after. Erwal thought of cautioning them to be careful; but she stopped herself, almost amused. What precautions were there to take? Either the Eight Rooms would save their lives... or they would have to turn back, try to reach the village before the worst of the winter set in, and wait, exhausted, for the cold to kill them.

Either way there wasn't much point in being careful. Stiffly, Erwal made her way through the snow to the Eight Rooms.

The children were soon clambering in and out of an open doorway. Erwal paused some distance from the structure and studied it carefully. She recalled Teal describing his shock at seeing how the building floated, unsupported, a foot in the air; and, bending down, she saw a strip of snowy land beneath the Rooms. She frowned, puzzling at her own un-startled reaction. What was the great wonder? Every child heard stories of how powerful the ancients had been, of how they had built the very world humans lived in; why should a box floating in the air be such a surprise?

She sighed. Perhaps she simply wasn't very imaginative. Briskly she approached the Rooms, paused only briefly at the doorway, then stepped up and over the foot-high sill--

-- and nearly fainted as she entered warm, still air. She felt blood rush to her face, and, seeking support, she

reached out to a wall -- and pulled her fingers back, shocked. The material of the wall was warm and soft, like flesh. Arke joined her, running a callused palm over the wall. "Isn't it remarkable? Perhaps this whole building is a living creature."

"Yes." Feeling stronger she turned and surveyed the Room. There were hatchlike doors in all four walls, and in the floor and ceiling; through each door she could see people in other Rooms running fingertips over the walls, their expressions slack. "It's very strange..."

...Wait a moment. Rooms beyond each door? But this one Room was big enough to fill up the cube she had seen from outside, so that beyond the doors should be only snow or sky...

And yet there were Rooms where there was no space for them.

Vaguely she remembered Teal's impatient descriptions of how the Rooms were folded over each other, and briefly she struggled to understand. Then she sighed, deciding to put the mystery of the folded-up place out of her mind. If it didn't bother the children, why should it bother her?

Arke went on, "Erwal, we've done well, even if we go no further than this. We are warm and dry, and we still have the mummy-cow for food. We could stay here, bring the mummy-cow inside, allow the children to grow..."

"But that's not why we came here," she said, suddenly impatient. "Teal went further." She looked up, recalling how Teal had described climbing up through the roof hatch. "Come on," she told Arke. "Help me up."

Arke allowed her to climb onto his shoulders; soon others, already in the upper Room, were pulling her up through the hatch/door.

The upper Room was just like the first, with light from nowhere filling the air. A few adults stood here, looking lost. Silently she climbed to her feet. She tried to picture

Teal as he had taken these steps. Straight ahead from the hatch in the floor, he had said, and push at the door...

Beyond the door was the Eighth Room. It was shaped like the rest but its walls were clear, as if made of ice.

Beyond the walls was a black sky sprinkled with tiny lights.

There was a body on the crystal floor.

Arke stood beside Erwal. "Are they 'stars'?"

Shuddering, she said: "That's the word Teal gave us."

"And that--" He pointed straight ahead; beyond the farthest wall an object like a large, black seed pod floated in emptiness. "Do you think that's the 'ship'?"

Erwal tried to speak but her throat was dry.

She forced herself to look down.

The body was little more than bones swathed in rags of clothing. In one clawlike hand it clutched an elaborate knife. Erwal bent, took the knife; the skeletal fingers fell to pieces, clattering against the warm material of the floor. "This was Allel's knife," she told Arke. "Teal's grandmother. Teal treasured this knife."

Arke held her elbow. "It's a miracle he made it this far, you know. And the second time he came he didn't have a mummy-cow."

"He died alone. And so close to his goal."

"But he didn't die in vain. He brought us here."

Erwal, trembling, walked to the wall nearest the ship. "Now all we have to do is work out how to get out of here."

The others watched her, their faces pale with awe.

It is not true to say that Paul waited beside the Eighth Room after the brief appearance of the first human. Rather, he assigned a subcomponent of his personality to monitor events within the Room, while he turned the rest of his multiplexed attention elsewhere. And it could not be said that Paul's patience was tested by the subsequent delay. After all he was largely independent of the constraints of

time and space; and the galaxies were available for his study.

And yet...

And yet, when humans reappeared in the Eighth Room, it seemed to Paul that he had waited a very, very long time.

The humans stared at the star-strewn Universe and retreated in alarm. Paul was fascinated by their angular movements, their obviously limited viewpoints. How unimaginably constraining to have one's awareness bound into a box on a stalk of bone!

But as Paul continued to observe, memories of his own brief corporeal sojourn on the Sugar Lump stirred, oddly sharp. Godlike, uncertain of his own reaction, he watched men, women and children talk, touch each other, laugh.

He noticed the ragged, filthy clothes, the protruding ribs, the ice-damaged skin. He pondered the meaning of these things.

Eventually a gray-haired woman entered the Room. Her behavior seemed different; she walked slowly to the crystal wall and stared out steadily at the stars.

Paul focused his attention so that it was as if he were gazing into her eyes.

The face was fine-boned, the skin drawn tight over the bones, and age had brought webs of wrinkles around the eyes and mouth. The skin was scarred, the lips cracked and bleeding. This was a tired face. But the head was held erect, the eyes locked on a Universe which must be utterly baffling.

And behind those eyes a quantum grain of consciousness lay like an unripened seed, shaped by millions of years.

The woman left the Room; Paul, oddly shaken, reflected.

Over the next few days the humans investigated their crystal box. They touched the walls, staring through them with blank incomprehension. They were clearly aware of the spacecraft which lay waiting just beyond the Room's walls: they pointed, knelt so they could see under it, and

occasionally one of them would paw at the walls; but there was no pattern to their searches, no system; they deployed no tools beyond fingertips and tongues. But they showed no frustration. They were like children in an adult world; they simply did not expect to be able to make things work.

At length there was a flurry of activity at the brightly-lit doorway. The humans were goading some sort of animal into the Room: here came a barrel-like head, a broad, solid body covered by shaggy fur. The humans punched the beast's flanks, tugged at the hair above its trembling eyes; the creature, obviously terrified, was almost immovable. But at last it stood in the center of the Room, surrounded by sweating, triumphant humans. It looked to left, right, and finally down at its feet. Paul imagined its terror as it found itself standing on apparent emptiness light years deep. The great head rotated like a piece of machinery and the beast scurried backward through the door, bowling some of the humans over. The people ran after it, shouting and waving their arms.

Paul, bemused, withdrew for some time.

These people were clearly helpless.

Crushed by uncounted generations in their four-dimensional cage, they had lost not only understanding but, it seemed to him, also the means by which to acquire a greater understanding. The Eight Rooms and the waiting ship were obviously intended to be found and used by the humans. But these ragged remnants were incapable of working this out.

This rabble was the relic of a race which had once had the audacity to challenge the Xeelee themselves. The strands of Paul's persona sang with contempt and he considered abandoning the humans, returning to his contemplation.

...But then he remembered the gray woman, the quantum jewel which had sparkled even within its battered

setting of bone and dirt, and his contempt was stilled. Even fallen, these were still humans.

Slowly, almost hesitantly, he returned to the Eighth Room.

After the absurd attempt to push Sand into the Eighth Room, the novelty of the crystal box had worn off. The Room was left mostly empty as the villagers spread through the comfortable, opaque interiors of the other Rooms, laying their filthy blankets over fleshlike floors. Soon it seemed that Erwal could scarcely walk a yard without tripping over some running child or the outstretched legs of its parent. The purposeless, almost lazy mood was only to be expected, she supposed. Life in the village had been an endless round of cold and dirt, made only more meaningless by the endless legends of man's great past. The Eight Rooms were the driest, warmest, most comfortable place any human alive had ever seen...

But they had not come here for comfort.

Again and again she was drawn to the mysteries of the Eighth Room. She would lie on her back on its body-warm floor staring up at the star-buildings; or she would lie facedown, her nose pressed against the clear floor, and imagine herself falling slowly into that great, endless pool of light.

She studied the craft beyond the wall. It was some thirty feet long -- nearly three times the size of the Room -- and shaped like a fat, rounded disc. It was utterly black, showing only by starshine highlights. It was completely beyond her experience... but she knew what it was. Teal had told her what to expect, with his strange tales of men traveling among the stars.

This was the ship. It was a vessel to take them... somewhere else. (Here her imagination failed.) The Eight Rooms were merely a way station. But if they were to go on they had to find a way through these walls! She laid her

palms flat and passed them over the warm, crystalline stuff. But this was not a teepee; there were no flaps to open. She slapped the wall in exasperation.

The gray-haired woman was frustrated! She wanted to explore!

Paul exulted. He slid quantum tendrils into her skull.

...She spread her hand wide and folded the fingers forward so that they formed a kind of cylinder; then she pressed her fingertips against the wall, just -- here...

Erwal gasped and staggered away from the wall. She stared at her hands, flexing them and turning them over, as if to reassure herself that they were still under her control.

It had been like a waking dream.

It could have lasted no more than a second. She had seen her hand reach out and touch the wall in that odd way -- it had been her own hand, undoubtedly; she had recognized the patch of white, frost-killed tissue near the center knuckles -- but the vision had been laid over the sight of her real hand, which had remained resting against the clear wall.

She wrapped her arms around herself and retreated to the door of the Room. For some minutes she allowed the warm, human noises of the villagers to seep over her. She had felt able to cope with her bizarre experiences up to now: she had the stories of Teal to cling to, and as long as it was all *out there*, as long as she, Erwal, wife of Damen, remained the same, with her comfortable skin smock and her tiny collection of possessions, then she felt strong and able to endure.

But this was different.

Something had reached inside her head, and for the first time since she had left the village she experienced real terror. She wished Teal were here; surely he would be able to understand this...

She took a deep breath and closed her eyes. Teal wasn't here. And in any event he hadn't been able to go beyond this point himself. There was no use hiding in helplessness; the meaning of the vision was obvious. Someone, or something, had shown her the way out of here. Who it was, and how they had done it, she didn't know. Nor did it matter. Now she had to decide what to do. She could return to the warm fug of the villagers and forget about the challenge of the stars...

Or she could follow these clear instructions.

And what would happen then?

It was just as well she was so unimaginative (she walked back to the far wall) for if she had the faintest inkling of what she might unleash (she lifted her hand as in the vision, made a tube of her fingers) she would certainly never approach the wall and stab her fingers just so--

Nothing happened.

She leaned against the wall, trying to stop the shaking of her body, and stabbed again and again.

Suddenly there was a hole in the wall. It was a circle a little shorter than she was, and it led into a wide, well-lit room -- a room inside the ship.

Suddenly her will broke and she ran, sobbing, from the Eighth Room.

The humans stepped cautiously through the circular opening and stood, incongruous in their furs and leggings, at the center of the ship's single chamber. Chairs of some dark, soft material lay scattered over the deck. The chairs were fixed in place but the humans quickly discovered that they would, with a judicious rock backwards, convert into couches. Soon the children were swarming over the devices, rocking back and forth.

Paul, watching, considered this. These chairs were so clearly designed for humans; in fact, of course, the whole life-system was human-based. And yet the rest of the ship



showed few of the characteristics of human technology. Paul's attention foci prowled. The chamber occupied by the humans was a flat cylinder which, Paul realized, filled most of the ship's volume; its drive units, life support and other equipment must be embedded in the hull. And when he studied the paper-thin hull itself he found space-wings furled into tight coils within the body; and he discovered how it would be possible to expand collapsed compartments in the hull to accommodate hundreds, thousands of people.

Sadly this wasn't necessary.

Slowly the humans colonized the comparatively spacious environs of the ship. They spread their foul blankets over the floor, argued over occupancy of the couches, and even tried to goad the poor animal through the Eighth Room and into the ship. Soon they were hanging up their blankets to separate the chamber into a series of private cells.

The ship meant no more to them than would a comfortable shack, Paul realized, amused and irritated.

Only the gray-haired woman showed any continuing curiosity in the ship itself. She prowled the walls, touching, staring, studying. There were panels which showed scenes of stars, but they were not simple windows; they showed images which were magnified, inverted, or distorted, as if seen sideways in a reflecting sheet of ice. Other panels, larger in area, coated the lower walls like silver paint. And to a table fixed beneath an array of panels were attached devices which Paul instantly recognized as waldoes, tailored for human hands. Obviously this was the ship's control system. With a mixture of fascination and dread Paul watched the woman approach the strange, mittenlike objects; she poked at them tentatively, and once even appeared to be contemplating slipping her hands inside. But she backed away nervously and moved on.

Paul, with the wave-function equivalent of a sigh, resigned himself to waiting a little longer.

Erwal ran her fingers over the ship's gleaming surfaces. She stared at the panels, the strange mittens, the shaped chairs, and tried very hard to understand.

She stood before a silver wall panel. The featureless rectangle, about as tall as she was, reflected a tired, uncertain woman. Perhaps she simply wasn't up to this. If only Teal were here--

...She reached out her right hand and slid it through the silver panel, as if it were a pool of some liquid stood impossibly on end; she felt no discomfort, only a mild, vaguely pleasant tingling...

The dream evaporated. Her hands were safely by her sides. She held her right hand up before her face and poked at it, turning it over and over; it was unaffected, right down to the familiar patch of frost-bitten skin between the knuckles.

She found herself shuddering. The vision, like the first one, had been as real as life. It was as if her grasp on reality were loosening. She closed her eyes and stood there, alone in the muddy bustle of the ship, wishing beyond wish that she were with Damen in the warm, dark security of her teepee.

She forced her eyes open and stared at the silver panel. It shone softly in the diffuse light. She recalled reluctantly how useful the first of her waking dreams had turned out to be, the one that had shown her how to get into the ship. Perhaps this latest one would be just as valuable...

If she had the courage to find out.

She reached out a trembling hand. Her fingertips touched the gleaming panel, then slid without resistance into the surface. To her eyes it was as if the fingers had been cut away by a blade; but she could feel them in the unknown space behind the panel, and she wiggled them experimentally. She felt nothing; it was as if the panel was made of air, or some warm liquid.

She withdrew her fingers. There was no resistance. She inspected her hand carefully, pinching the skin, then looked doubtfully at the panel once more.

Almost impulsively she thrust her hand right through the silver, immersing it to the wrist. She felt nothing but a vague, deep warmth; her stretching fingers found nothing within the hidden space.

She pulled her hand away once more, studied it and flexed her fingers. It felt, if anything, healthier than before; as she moved the joints she was untroubled by the stiffness she sometimes suffered in her knuckles...

It felt much healthier, in fact. And it was now completely unmarked. The patch of frostbite between her knuckles was gone.

The news of the miraculous healing panel spread rapidly. Soon hands, forearms and elbows were being thrust through the silver curtain; they returned freed of cuts, bruises and patches of ice-damaged skin. Arke had a slightly sprained ankle, and he lifted his leg and comically thrust his foot through the silver curtain. Afterwards he strode around the chamber grinning, declaring the joint to be stronger than it had ever been.

One five-year-old was suffering from a debilitating chest infection, and in his father's hands he looked little more than a disjointed sack of bones. At last the father thrust the child bodily through the partition. Tears streaming down his face, he held the boy out of sight for several heartbeats.

When he pulled his son back the villagers crowded around expecting a miracle, but the boy appeared just as thin and pale as before. The father smiled bravely at the child, who was excitedly describing how dark it had been in there. The villagers turned away, shaking their heads.

Erwal kept her own counsel and watched the boy.

The improvement was only gradual at first, but after a few days it was beyond doubt: the boy's cough subsided,

color returned to his cheeks, and, at last, his weight began to pick up. Everyone was moved by this and there was an impromptu party, with the boy's recovery toasted in wooden beakers of mummy-cow milk.

Erwal reflected carefully on the incident and tried to understand its meaning.

Over the next few days she experienced several more of the waking dreams, and gradually she learned to trust them. She reached into more silver panels and pulled out food and drink of a richness the villagers had never experienced before. That was an excuse for another party... Then she learned how to touch the floor -- just so -- to make a section of it open up to reveal a pool of warm, clear water. The villagers had never seen so much water standing unfrozen, and they stared at it uncertainly. The children were the first to try it out, and soon the adults found it impossible to resist joining in their games. Dirt floated away from Erwal's flesh, taking with it some of the burden of responsibility she had carried since leaving the village. The pool was soon reduced to dilute mud; but, as soon as Erwal had the floor close and open again, the water was restored to its clear purity.

The villagers took these miracles in their stride. As Erwal delivered each new surprise they would stare at her curiously, one or two questioning her on how she had known to touch the panels or the walls in just that fashion; but, unable to explain the waking dreams only she experienced, she would simply smile and shrug.

Perhaps there was something in the ship which sent the dreams to her. After all a dreaming panel would be no more miraculous than a healing panel...

But she could not believe that. There was an element of patience and sympathy about the visions that reminded her of people who had cared for her in the past: of her mother, of Teal, of old Allel. Surely there was a person behind these visions; and surely that person was a human like herself.

Gradually she came to think of her benefactor as the Friend.

She wondered why he -- or she -- did not simply walk through the door of the ship and show himself. She suspected she would never know his name. But she became convinced he intended only to help her, and she sent him silent thanks.

But then a new set of visions began, and soon she wished she could close off her mind as she could close her eyes, block her ears.

In these new dreams she was sitting at one end of the chamber, at the table to which were fixed the strange, soft mittens. She would slide her hands into the mittens and spread her fingers flat against the tabletop. That in itself did not seem so bad... but then would come a helpless movement, like sliding across a plain of ice, and the dream would become a nightmare.

Terrified, she resisted the dreams, but they battered at her awareness like snowflakes. Even sleep was no escape. She sensed an urgency behind the dreams, an anxiety; but there was also tolerance and kindness. Obviously the Friend badly wanted her to slide her hands into the mittens, to submit to this awful falling sensation. But she felt that if she failed to overcome her terror the Friend would stay and help her care for her people, here in the Eight Rooms and the ship, as long as they lived.

Finally, after some days, the dreams ceased. Perhaps the Friend had done all he could and was now waiting, resigned to whatever decision she might make. She grew restless in the confines of the ship and the Rooms, fractious and impatient with her companions, and she slept badly.

At last she approached the little table. Two of the children played a noisy game around her feet, barely noticed. She sat down and slid her hands into the mittens. She felt a million tiny prickles, as if the gloves were stuffed with fine needles, but there was no pain.

The ship quivered.

She gasped; the thrill that had run through the fabric of the ship had been almost sexual in its intensity, as if she were touching a lover.

She became aware of a lull in the noise of the chamber. The villagers had felt the ripple and looked about uneasily, their new home abruptly an alien place once more.

Slowly she opened her fingers, turned her hands palm down, and deliberately rested them on the tabletop.

Now another shudder ran through the ship; she imagined a giant waking, stretching huge muscles after too long a sleep. Fear flooded through her; but she kept her hands steady and clung to the idea that the Friend was hovering over her somewhere. Surely the Friend would not lead her into harm.

Arke came bursting into the chamber. He stared around wildly, sweat sparkling on his bald scalp. "Erwal! What are you doing to the ship?"

She turned. "What are you talking about?"

He gestured, swinging his arms through wide arcs. "You can see it from the Eighth Room. The ship has grown wings! They must be a hundred miles long and they're as black as night..."

Erwal barely heard him, for her head was flooded with a new series of dreams, as if the Friend were now excited beyond endurance. She closed her eyes, shook her head; but still the visions persisted. She could see the Eighth Room, but from the outside; it was a crystal toy against a backdrop of stars... and the ship was gone from its side.

She had no idea what the vision meant. Again and again it pounded into her head like a palm slapping her temple. At last, terrified and confused, she... reflected... the vision back.

There were screams; she heard people fall, splash into the pool. Then there came that terrible dream-sensation of sliding--

With a cry she snatched her hands from the mittens. There was an instant of pain, of regret, as if she were spurning a lover. The sense of motion ceased.

She stared around. Baffled villagers clung to each other, crying. The door which had led to the Eighth Room had sealed itself up. In one of the wall panels she saw the Eighth Room... but, just as in the dream, the Room was diminished in size, as if she were viewing it from some distance.

A muscle in Arke's cheek quivered. "Erwal, what have you done?"

"I..." Her throat, she found, was quite dry. She licked her lips and tried again. "I think I've moved the ship. But I'm not sure how."

He pointed to the door. "If that hadn't closed itself the connection to the Room might have just ripped open." He eyed her accusingly. "What if someone had fallen? Or what if the door had closed on one of us, perhaps a child? They might have been cut in two."

Her fears subsiding, Erwal found herself able to say calmly: "Arke, I don't think that could have happened. The ship simply isn't made that way. It's here to help and protect us."

He stared at her curiously, scratching his scalp. "You talk about it as if it's alive."

"Perhaps it is." She touched the mittens and remembered the excitement that had surged through her senses.

"Take us back." There was a barely controlled tremble in Arke's voice.

She looked up at the wall panels. Villagers inside the Eighth Room called soundlessly to the ship, hammering at the crystal walls; they looked like insects in a box of ice, and the occupants of the ship stared at them numbly.

Erwal nodded. "Yes. All right." Once again she slid her hands into the gloves; once again the ship trembled, as if it

were some huge animal ready to do her bidding.

She sensed the Friend hovering close by.

She closed her eyes and -- imagined -- the ship restored to its berth next to the Eighth Room. There was another disconcerting slide through space, briefer this time, and the ship came to rest.

She looked up. The door barring the way to the Eighth Room had dissolved; the villagers in the ship rushed to the door and embraced their companions, as if they had been separated by far more than a few hundred yards and a few minutes.

After that many of the little group retreated to the comparatively familiar confines of the Eight Rooms -- some went so far as to spend some nights outside, buried in the chill, comforting snow -- and it took some time before they grew to trust the interior of the ship once more. For some time Erwal did not dare move the ship again; but when she slid her hands into the mittens it was like the feel of the muscles beneath the thick hair of Damen's forearm.

Paul exulted.

Unsophisticated the humans might be, but they were not primitive, Paul saw clearly. They had been shaped by the habitation of a Galaxy, over millions of years. The woman, for all her fear and tentativeness, had no difficulty with grasping the essential concepts -- that the object she sat in was a ship, which could be directed through immense spaces -- despite the fact that such things were so far beyond her own experience. It was as if humans had evolved for spaceflight, as if the imaginative concepts required were embedded in deep mental muscles in the woman's brain -- atrophied perhaps, but now stirring anew.

Paul tried to analyze his own reactions. Not long ago he had been near the peak of his sophistication, his awareness multiplexed and his senses sweeping across the Galaxy... Now he was spending so much time locked into a crude



single-viewpoint self-awareness model in order to communicate with the pilot woman that he was in danger of degenerating.

Why was he doing this? Why did he care?

He shook off his introspection. There were greater issues to resolve. He had focused so long on the question of teaching the humans to fly the ship that he had neglected to consider *where* they were meant to take it. Already he sensed the most advanced one, the woman pilot, was beginning to frame such questions.

He must consider.

He withdrew from the woman. (There was a sharp, bittersweet sense of loss.) Then his awareness multiplied, fragmented, and spread like the wings of the ship, and the small pain vanished.

The watching Qax had become aware of the quantum-function creature through its interaction with the primitives, and had only slowly come to recognize it as an advanced-form human.

Now the evolved human had gone.

The Qax considered.

The primitive humans were helpless. There would be time to collect them later.

The Qax departed, following the evolved human.

The Friend had gone.

Erwal worried briefly; but he would return when she needed him.

And in the meantime there was the ship.

Inside the warm stomach of the ship the days were changeless, their passing marked only by sleep intervals.

Erwal found a way to dim the light in the main chamber, and each "evening" the villagers would retreat to their nests of blankets, and soon a soft susurrus of snoring,

gentle scratching, of subdued belches and farts, would fill the clean walls of the ship.

Erwal found it difficult to rest.

Nights -- "nights" -- were the times she missed Damen most. She lay alone in her cordoned-off space for long hours, staring up at the featureless ceiling. At length, driven by the boredom of sleeplessness, she would steal past sleeping bodies to the control table, slip her hands into the warmth of the mittens, and once more touch the great muscles of the craft.

She could not put aside the thought that they had not come so far simply to stop here. They had braved the snows to reach the Rooms -- they had learned to use the ship's facilities to feed and cleanse themselves...

They could even make it fly.

Surely they should not simply give up? If they could make the ship fly, why should they not make it fly far and wide in this strange, roofless Universe?

The claustrophobic warmth, the cosy human scents of the cabin, closed in around her once more.

She wished the Friend were still here. But she was alone, with her frustration.

Arke came to her, concern creasing the flesh between his eyes. "You worry me," he said softly.

"Then I'm sorry. There's no need--"

"Erwal, most of us are happy simply to have reached this haven. Warmth, safety, peace, food -- that's all we ever wanted. We don't want more uncertainty, adventure. You know that. But you -- you are different. You seem driven," Arke said.

Perhaps she should tell Arke about the Friend -- what a relief it would be to share her doubts and uncertainties with another! -- but Arke, good man as he was, would surely conclude that she was simply insane; and she would never again be allowed to use the controls without the watchful eye of a villager on her.

Anyway, she reflected, at the moment the Friend wasn't here! So whatever was impelling her, making her restless, was coming from inside her.

She leaned forward and peered into Arke's pale, anxious eyes. "I think we have to go on. We can't stop here."

He spread his hands. "Why? We are comfortable and safe."

"Arke, this ship isn't just a teepee. It flies! Look -- someone built the Eight Rooms for us to find. Didn't they?"

Arke nodded slowly. "Someone who knew we would need to escape the ice one day."

"So they released us from one danger -- the cold. But, Arke, why give us a ship as well? Why not just stop at the Eight Rooms?"

Arke frowned. "You think there's something else -- another danger; something we would need to escape in the flying ship."

"Yes." She sat back, resting her hands on her knees. "And that's why I think we have to learn to use this vessel."

Arke rubbed his broad nose. "Erwal, you've been right about a lot of things before. But--" He gestured at the sleeping villagers. "We aren't pioneers. We only came so far because the alternative seemed certain death. And even if you're right, this mysterious danger might not manifest itself for a long time -- for lifetimes, perhaps! So why should we not relax, let our children worry about the future?"

Erwal shook her head, remembering the urgency of the Friend. "I don't think we have lifetimes, Arke."

Arke spread his hands in a gesture of helplessness. "Frankly, Erwal, I don't see why the rest of us should let you endanger all our lives."

She nodded. "Then consider this: Arke, would you let me take the ship away alone? -- Then I would only be endangering myself, after all."

He scratched his chin. "But the food lockers--"

"I wouldn't take the mummy-cow," she said briskly. "No one would starve."

"I don't know..."

She took both his hands in hers. "Arke, I've saved all your lives. Now I think I am saving them again! Don't you owe it to me to let me try?"

He stared up at her uncertainly, the lines of his face softened by the twilight of the chamber.

"Let's talk to the others in the morning," he said.

There was grumbling, complaint at the possible loss of the ship's wonderful facilities -- and, Erwal was moved to find, genuine concern at her own welfare.

But they agreed.

It took a couple of days for the villagers to set up camp in the Eight Rooms once more; but at last the ship was cleared, save only for a few stray blankets, garments and other oddments. Erwal spent the time experimenting with the ship's panels, trying to work out a destination.

There was a light hand on her shoulder. Erwal turned. "Sura..."

The girl smiled down at her. "Are you ready?"

"What are you doing here?"

The smile broadened. "I couldn't let you go alone, could I?"

A soft warmth was added to the brew of exhilaration and fear already swirling within Erwal. Briefly she covered Sura's hand with her own -- and then turned to the controls and slid her hands into the mittens.

The ship quivered.

Paul brooded over the wreckage of the Solar System.

Since the retreat of the Xeelee the Universe had been lost to baryonic life forms. The photino birds had not yet completed their vast conversion programs -- stars were still shining, the Ring not yet closed -- but at last, in a time not

very distant, the final light would be extinguished and the baryonic Universe would grow uniform and cold, a stable home for the photino birds.

A shipful of primitive humans had no possibility of survival in a Universe occupied by such a force.

Therefore the humans would have to follow the Xeelee. Perhaps this escape had been the intention of the Xeelee all along, Paul mused. Perhaps they had provided many other junior baryonic races with similar "lifeboats," so they could follow the Xeelee to a place where baryonic life was still possible.

He saw it now. His humans would have to use their ship to cross space and pass through Bolder's Ring.

And Paul would have to guide them there. He felt a surge of determination, of anticipation...

And of fear.

Around his decision the diffuse cloud that comprised Paul's awareness coalesced. He prepared to return to the ship--

But there was something in the way.

Paul stopped. He assembled awareness foci to consider the new barrier, confused. The wave-function guides he was following had been distorted, even terminated, and--

He was being watched.

Paul froze, shocked; his sub-personalities condensed into something almost as coherent and limited as his old corporeal self.

There was something here: something aware and able to study him... and to stop him.

As if trembling, he tried to respond. The data that formed his being was stored in a lattice of quantum wave functions; now he distorted that lattice deliberately to indicate an omission. A lack. A question.

-- *Who are you?* --

The answer was imposed directly on his awareness; it was like being exposed to a raw, vicious dream, to a million years of venom.

-- Qax. --

The gateway between the Eighth Room and the ship healed shut, leaving Erwal and Sura alone in the ship.

"Where shall we go?" Sura asked innocently.

Erwal smiled. "Well, that's a good question." And, she realized, she barely knew how to start framing an answer. She flexed the gloves, and the panels, which had been displaying scenes of stars and of the Eighth Room, now filled with representations which were obviously artificial.

Sura stared at the graphic circles, the cones and ellipses, with confusion. "What does all this mean?"

Erwal withdrew her hands from the mittens. "I can only guess. But I think these pictures are meant to show us what this world is like." She reached up to grasp Sura's hand. "Sura, you know that the world we came from was like a box. There was the Shell below our feet, and Home above us, closing us in."

Sura sniffed. "Any child could see that."

"Yes. But now we've come out of that box; and out here it's different. There is no box anymore! The Eighth Room, the doorway to the box, is just -- hanging there."

"The way the first Room was hanging over the ground, when we found it?"

"Yes, but -- even more so," said Erwal, struggling to make sense. "It simply hangs! And there is no ground above it, or below it, as far as I can see. Just empty space, and a great pit of stars."

Sura, her mouth hanging open, thought it over. "I feel scared."

*So do I*, Erwal thought grimly; and she reflected on the many times she had instinctively sought a colorful roof-world over her head, and how she had cowered in her seat,

wishing she were at home in her teepee with a hard roof of rock between her and the stars.

Sura studied images of the Eighth Room. "If we've just come out of a great box -- through the Eighth Room -- then why can't we see the outside of the box from here? All you can see is the Room itself!" Sura sounded aggrieved, as if this were an affront to her intelligence.

Erwal sighed and pushed a lock of hair from her brow. "That's just one of a hundred -- a thousand things about this situation I don't understand at all. I think we have to proceed with what we can understand."

"And what's that?" Sura asked irritably. "Because none of this makes any sense so far."

Erwal pointed to a particular schematic. This showed a bright light, little more than a dot, surrounded by nine concentric circles. A small, framework cube sat on the third circle from the center, slowly following the track in an anticlockwise direction; a complex arrangement of light points similarly followed the sixth circle. The other circles were empty. "Look at that," said Erwal. "What does that remind you of?"

Sura reached out and, with one finger, touched the framework cube. The screen blanked and filled up with a magnified image of the cube; Sura snatched back her finger, startled.

Erwal laughed. "Don't be afraid. The panels won't hurt you."

"The box is the Eighth Room."

"That's right." Erwal touched a blank part of the image and the circles returned. "I think this shows where the Room is, you see. It's following this circular path around the bright light. And here's -- something else -- following the sixth circle."

"What's the bright light?"

"I don't know."

Sura touched the bright point; it expanded to show a dim globe, yellowing and pocked by huge dark spots. "Do you think we should go there?"

Erwal shrugged. "I don't know."

Sura restored the image of circles and counted. "Nine circles. We're on the third, and this other marking is on the sixth. But the other circles are empty. I wonder why."

"I don't know," Erwal said. "Maybe there were things there originally, which were destroyed. Or taken away."

"What could they have been?"

"Oh, Sura, how should I know?"

"I'm sorry." Sura studied the picture. "Well, then; there seems to be only one place to go."

"The sixth circle?"

"Yes. But how do we get there?"

Erwal smiled at her, slid her hands into the mittens once more, and flexed her fingers. A feeling of power, of release, swept over her. "That's the easy part," she said slowly. "I just close my eyes--"

The ship had waited a million years for this.

It spread its sycamore-seed wings wide and soared through the wreckage of the Solar System, barely restrained by the tentative will of the woman at the controls.

Erwal and Sura felt waves of motion-echoes. It was, thought Erwal, like being a child again and riding the shoulders of a lively mummy-cow.

Sura laughed and clung to Erwal's neck.

Within minutes the voyage was over; the ship, cooling, folded its wings.

The women stared up at the view panels.

At the heart of the sixth-circle complex was a single, immensely large, flattened sphere of gas. Much of the gas glowed a dull red, the color of burnt wood, although here



and there fires still raged within the atmosphere, blurred patches of yellow or white. Three smaller globes, equally spaced, circled the center sphere; their panel images bristled with detail. Further out there was a ring of debris, broad and softly sparkling; Erwal wondered if there had once been still more of these globes, now long since destroyed.

She bade the ship slide around the limb of the fireball. She watched the burning landscape unfold beneath her, and shivered with a sudden sense of scale. "Sura, that thing is immense."

"What is it? Is it a sun?"

"Perhaps. But it is far bigger than our Sun ever was. And it seems to be nearly burnt out now."

"Perhaps it lit up the smaller globes," Sura said brightly. "Perhaps people lived on the other globes, and set fire to this one to give them warmth. Erwal, is that possible?"

"Anything's possible," Erwal murmured.

The ship had dipped so close that it had flattened into a landscape of glowing gas. Erwal felt a sudden thrill of apprehension. Without hesitating she pulled the ship up and away from the Sunworld.

"Let's go see the smaller globes," she said to Sura.

Beneath Saturn's ruined atmosphere, ancient defense systems stirred.

Erwal brought the ship to the nearest of the globes. Soon the little world filled a panel; from pole to pole it was encrusted with detail, so that its surface reminded Erwal of fine leatherwork -- or, perhaps, of a cow-tree overrun with lichen and moss. She spread her wings and swooped close over the surface: a miniature landscape rushed with exhilarating speed beneath her bow.

Sura clapped her hands, childlike.

Erwal studied the panel. Now she saw that the surface was coated with buildings: they were all about the scale of the Eighth Room, but they came in every shape Erwal could imagine -- domes, cubes, pyramids, cylinders and spires -- and there were bowls and cup-shaped amphitheaters lying open to the sky. Arcs and loops of cable, fixed to the buildings, lay draped over the landscape, knitting it all together like some immense tapestry.

Nowhere did Erwal see an open space, a single blade of grass. And nowhere did she see any sign of people.

With immense care she bade the ship settle to the top of one of the broader buildings. Sura wanted to climb out and explore -- perhaps see what was inside the mysterious buildings -- but the ship's door would not open.

"I think the ship knows what's best for us," Erwal said. "Maybe we shouldn't go outside. It might be too hot -- or too cold -- or perhaps it's dangerous for us in some other way we can't imagine."

"But it's so frustrating!"

Erwal frowned. "Well, perhaps there's something I can do about that." She slid her hands into her mittens. "Here's something I found a few days ago. Come and see."

The panel over the control table showed the blank exterior of a bubble-shaped building; a circular door led to an intriguing -- but darkened -- interior. Now Erwal moved her thumbs, raised her wrists -- and the field of view of the window panel moved forward. It was as if the darkened doorway was approaching.

She felt Sura clutch the back of her chair. The girl said, "Erwal, are we moving?"

"No," Erwal said slowly. "But the picture is. Do you understand?" She waited nervously for the girl's reaction. Oddly, of all the miracles Erwal had encountered, she had found this one of the most difficult to absorb. So she was in a craft that traveled through emptiness: well, birds flew through the air, did they not?... And it was well known that

humans had once built such crafts as routinely as Damen now built a fire. Even the Friend's visions were reminiscent of dreams she had endured before, particularly since the final disappearance of Teal. So these phenomena were just extensions of the familiar.

But a window was just a hole in a teepee, with a flap to gum down when the wind rose. Obviously every time you looked through a window you would see the same scene.

The idea that a window, without moving, could show different scenes -- so that it was as if she were looking through the eyes of another -- was beyond comprehension.

But Sura stared at the unfolding image, eyes empty of wonder. She said: "Very nice. Can you make it go any faster?"

Deflated, Erwal sighed. Maybe she should give up trying to work these things out, and accept the windows, as Sura evidently did, for what they were.

Useful magic.

For the next hour and more they roamed vicariously through the abandoned streets of the city-world. This had obviously once been a world of people -- they recognized chairs, bedrooms, tables, all clearly human-sized. But there was no sign of humanity: no pictures on the walls, no decoration anywhere, no curtains or rugs beyond the severely functional. And building after building was filled with huge devices, quite unrecognizable to the two women: vast cylinders lying on their side or pointing through apertures at the sky, and rooms full of gray, coldly anonymous boxes.

Everywhere was darkness and -- Erwal felt -- coldness. The building-world had been left neat, perfect -- not a chair overturned -- and quite empty.

Sura, squatting on the floor, wrapped her arms about herself and shivered. "I don't think I would have liked to have lived here."

"Nor I." Erwal wondered about the purpose of all these banks of machines and boxes. The devices lacked the simple, human utility of the lockers she had found on the ship; these machines were brooding, almost threatening. Perhaps this was a world of weapons, of war.

Maybe, she thought, it was just as well they had found this place empty.

"Erwal." Sura stood gracefully and pointed at the image in the panel; an array of gray boxes was sliding away from them. "What's happening? Are you moving the image again?"

Erwal held her hands up before her face. "You can see I'm not. Sura, I don't understand what is happening." She thrust her hands into the gloves and changed the images in the panels; she looked below, above, to either side of the ship, half-expecting to espy a group of giant machine-men hauling at the ship...

Then she found something.

A tubular curtain, transparent but stained with blue, had fallen all around the ship. Its walls sparkled. The tube reached miles above the surface of the little world, and, looking up it, Erwal could see that it stretched all the way to the ruined Sun-world.

The ship was rising up this tunnel.

Soon the machine-world shrank to a fist-sized ball beneath them.

"Erwal! Do something! Take us away from here! If we crash into the Sun-thing, we'll be destroyed!"

But Erwal could only clench her mittened fists. "I can't," she said softly, staring at the panel. "I can't do anything. It won't respond."

The walls of the tunnel rushed by, a blur now.

A box had closed around Paul.

Of course it was not possible for Paul to be subjected to a simple physical confinement; nevertheless the wave-

function world lines which constituted his being -- and his link to Sol -- were bent to the point of breaking by the immaterial walls around him.

He couldn't move.

Shock and surprise surged through him. Of all the strange things he had seen in his travels this was the first to endanger him directly. With a startling shift of perspective he realized that he had come to think of himself as a god, an observer, invulnerable, above interference. Now he felt an overpowering urge to retreat into the cave of a simple quasi-human self-model... but if he went that way, madness and terror would surely follow.

Striving for order he set up limited sub-personalities to study his prison. Data began to reach him, and slowly he came to understand.

He was trapped in the focal zone of a radiation of an enormously high frequency. The zone was a sphere only a few feet across; nonlinear effects causing energy to cascade into lower frequencies must have made the zone glow like a jewel. Individual photons darted through the focus like birds, their wavelength a hundred billion billion times smaller than the radius of an electron; the short wavelength implied immense energy, so that each photon was a potent little bullet of energy/mass... in fact, so massive that each photon was almost a quantum black hole. And it was this that was confining him. Black holes cut the world lines of which he was composed; it was as if a corporeal human were confined by a web of a billion burning threads.

So it was an effective cage. The Qax had taken him.

That left one question: *why?*

Calm now, he rearranged the data strung along his wave-function components so that the omissions represented by the question were clear and sharp.

He waited. He did not trouble to measure the time.

...The Qax returned.

Paul rapidly assembled a set of multiple attention foci. There was a more coherent feel to the sleet of singularity radiation now; in a systematic fashion the frequencies, phases and paths of the powerful quanta were being modified by their passage through his being. He was being interrogated, he realized: each photon was taking a few more bits of data from him, no doubt for study by his captor. It was a data dump; he was being read as if he were some crude storage device.

He felt no resentment; nor did he try to hide. What was the point? His captor had to be aware already of the little band of humans skimming their crude ship around Sol's gravity well. His best hope was to let the Qax learn, wait for some kind of feedback.

But he kept his question representations in place.

Slowly he discerned a further evolution in the hail of photons. He spread his awareness as wide as he dared, and, like a man straining to hear distant fragments of conversation, he listened. He caught glimpses of the Qax itself, elusive impressions of something fast, quick-thinking, physically compact; the radiation cage imprisoning him implied a command of the deepest structure of the physical Universe.

...And he heard hatred.

The brutal fact of it was shocking, overpowering. The Qax hated him; it hated him because he was human, and that loathing warped the path of every photon that tore through him. The hatred dominated his captor's existence and was harnessed to a determination to expunge every trace of humanity from the Universe.

Paul felt awe at the crime that had caused such enmity across a desert of time.

The unequal flow of data continued for an immeasurable period. Then--

A change. The boundary conditions of his photon cage were being altered, so that the region of spacetime which restrained him was translated...

He was being moved.

Now there was another component to the complex rain of photons. Paul strained. There was another individual out there; something huge, vast, stately, with thought processes on timescales of hours, so that its slow speculations rang like gongs... And yet it too was a Qax; there was such a similarity to the structure of Paul's captor that the giant surely belonged to, or at least originated from, the same species. And still the drizzle of inferred data was not resolved; there were unattributed overtones, like higher harmonics on a violin string.

There were more of them out there, he realized, too many for him to discriminate as individuals, a vast hierarchy of Qax looming over him, inspecting him like immense biologists over some splayed insect. They existed on every imaginable scale of space and time, and yet they remained a single species -- scattered, multiply evolved, but still essentially united.

And they all hated him.

The photon cage disappeared.

Freed, Paul felt like a spider whose web has been cut. Rapidly he assessed the few quantum strands which still linked him to Sol, the Ring. Spiderlike, he set to work to build on those threads.

With a small part of him he looked around.

He was no longer in the Solar System. He saw a brown dwarf, a Jovian world ten times the size of Jupiter; it circled a shrunken white star. His focus of awareness orbited a few hundred miles above the planet's cloud tops. Studying the clouds he saw turbulent cells on all scales, feeding off each other in a great fractal cascade of whirling energy. A massive brown-red spot, a self-organizing island of stability, sailed through the roiling storms.

He mused over the spectacle, puzzled as to why he had been brought here. The energy for all that weather must come from the planet's interior and its rotation, rather than the wizened star. This monster world was self-contained and complete in itself: it didn't need the rest of the Universe. In fact, Paul reflected wryly, this world should be safe even from the depredations of the photino birds. While the dark matter foe turned stars to dust this world and billions like it would spin on, a container of massive but purposeless motion, until the energy dissipated by its huge weather systems caused its core to cool, its rotation to grind slowly down. Then at last it would come to rest, its only function being to serve as a gravitational seedbed for a photino bird Ghost world. The planet was harmless, dull and old; even that cloud spot might be older than mankind, he realized--

Again he was being watched.

A vast speculation thrilled through him. The huge Qax he had detected earlier, with thoughts like hours...

It was here. In the spot system. The whole self-organizing complex contained the awareness of a Qax, and it was studying him.

He opened himself. New data trickled into his awareness.

The Xeelee ship was semisentient. The function of the ship was to optimize the chances of survival of its human occupants.

It studied the machines working at the heart of the ancient Jovian, and considered how this might be achieved.

Once this System had been the home of a race who had waged war for hundreds of millennia. The Jovian had been reworked to serve as the hub of an industrial-military conurbation which had launched wave after wave of strikes out at the humans' perceived foe, the Xeelee. The ship saw how even the moons had been moved to their present



altitudes, their orbits regularized, to serve as weapons shops. Power for the shops, and for the great fleets which had poured out of this system, had come from the substance of the Jovian itself.

Now, of course, the war was history, the human fleets brushed aside; the shops were deserted and the Jovian was largely spent -- but still, the ship perceived, entities remained brooding at its core, vast machine-minds waiting to fulfill their final purpose--

The last defense of the Solar System.

They saw the Xeelee ship, with its cargo of two primitive humans, as a threat. And they had attacked.

The ship methodically studied the weak tractor beam which was drawing it steadily towards the Jovian.

Gravity wave technology -- called by the humans "starbreaker beams" -- had been one of the many Xeelee mysteries never solved by man, even after generations of study. The ship now recognized this tractor as a pale imitation of a starbreaker; and it made out, somewhere near the core of the Jovian, the generator which served as the core of the tractor. A group of point-singularities were being impelled, by strong electrical fields, to collide and coalesce. As pairs of the ultradense singularities impacted a new, more massive, hole would form; for some seconds the new hole's event horizon would vibrate like a soap bubble, emitting intense gravitational waves. By controlling the pattern of such collisions the modes of vibration of the horizons could be controlled -- and thus, indirectly, the tractor beam of gravity waves was generated.

It worked. After a fashion.

The ship computed options.

It could simply spread its wings and fly away, of course. But there would be a period, a second or so, when its discontinuity-drive impulse would match the tug of the tractor beam; and when the beam was broken the ship and its occupants could suffer a jolt.

The ship assessed the (low) probability of damage to the humans.

The second option was simpler and, the ship concluded, entailed less risk.

It fired its own starbreaker, straight down the throat of the tractor.

Sura cried out and covered her eyes; Erwal, squinting, saw how the panel's brightness dimmed to a point where she could see again.

She still looked along the curtain-tube to the Sun-world. But now a beam of intense cherry-red light threaded out of the ship and along the tube's axis, spearing the heart of the Sun-world. Around the point of impact the Sun-world glowed yellow-white; the stain of light spread until it covered perhaps a quarter of the globe's huge area.

The curtain flickered, fragmented, faded; the red beam flicked off, as if doused.

Sura lowered her hands cautiously. "Is it over?"

"I think so."

"What happened?"

Erwal changed the panel view to look out over the blocky building-world landscape, now brightly lit by the revived Sunworld. "I don't know. It's worked, whatever it was. We're no longer rising."

Sura stared up at the panel. "But -- look..."

The world was no longer dead.

Lights flickered on across the landscape; clear yellow or blue radiance poured from the doorways of the abandoned structures. Now some of the buildings began to rise from the ground, and Erwal was reminded of flowers which seek the Sun; soon the buildings were straining up at the Sun-world, their cables singing taut, and amphitheatres reached out like open palms; and for a moment she saw the machine-world as its builders must have intended it: as a place of vibrant power and industry.

Erwal felt her throat constricting. *Why, she thought, it is beautiful after all. I just wasn't seeing it right.*

But already the revived Sun-world light was fading; the building sank uncertainly to the ground, their interior illumination cooling to darkness.

It had lasted no more than a minute.

Sura said, "I think I'd like to go home now."

"Yes."

The ship spread its wings over the machine-world for the last time.

During his studies on the Sugar Lump Paul had learned of the history of the Qax. Paul's captor, constructed of the Virtual particle sets of the seething vacuum, resembled its forebears -- the odd, vast creatures who had spawned as constructs of convection cells in a boiling ocean -- as a laser rifle resembles a piece of chipped stone. But it could trace its consciousness back to that boiling sea.

And it remembered the human, Jim Bolder, who had once caused the Qax sun to nova.

Paul, his awareness tightly focused on the Jovian's roiling storms, began to piece together an understanding of the future plans of the Qax.

Unlike most baryonic species the Qax would be able to coexist with the dark matter photino birds. The Qax inhabited the turbulent, twilit depths of low-energy systems. It would not matter to the Jovian's Qax parasite, for example, if, thanks to the photino birds, its host's distant star failed to shine; as long as the planet turned and its inner core glowed with heat the Qax could survive.

So the Qax might become the last baryonic inhabitants of the Universe.

Eventually, though, the energy sources which fueled the turbulence sustaining the Qax would everywhere run dry. This Jovian would grow cold, exhausted by its own weather. Then, at last, it would be time for the Qax to leave. There

would be a second Qax exodus, on a far vaster scale than the first, as the race followed the Xeelee through their Ring to a fresh cosmos. Paul speculated wildly on the container vessel which could store a consciousness based on the rhythms of galactic orbits...

But the Qax weren't yet troubled by such problems. They were aware that the photino birds' actions had doomed the Ring. The Ring would close eventually: having won the Universe the photino birds were sealing themselves into it. But, the Qax judged, there was plenty of time.

And besides, the Qax had another project to complete. A loose end.

The final destruction of humanity.

The Qax had waited through the humans' brief, vainglorious morning as they grew to dominate the species around them -- only to waste their strength in the absurd assaults on the Xeelee. Eventually the Xeelee had gently sealed the majority of the surviving humans in the box-world beyond the Eight Rooms. Some small colonies of people in various forms had survived, however, and the Qax had watched as, one by one, these remnants dwindled and expired.

Paul suspected that the Qax had not been reluctant to speed this process.

Now the Universe seemed at last empty of humans. But after the actions of Jim Bolder the Qax judged that even a small group of humans represented a risk to the long-term survival of the Qax. So the Qax would ensure that humans would never again rise to threaten the species with their unpredictable plans.

They waited.

Eventually Teal had appeared in the Eighth Room.

Paul wondered wistfully why the Qax had not been disturbed when the antiXeelee had revived Paul himself; slowly he came to understand that he was not sufficiently human for the Qax to recognize him, and only by his

association with the villagers had they come to learn what he was.

He experienced a profound sadness.

The Qax had been heartened by the descent into savagery evidenced by the nature of Teal and those who followed him. They could, of course, have destroyed the humans at any time. But they had been patient. It was clear that there were more humans within and beyond the Rooms, still inaccessible to the Qax; and it was also clear that the emerging humans could have only one plan of action: to take the Xeelee ship across the lost Universe to Bolder's Ring.

For that last voyage, surely, all the humans would emerge from the protection of the Rooms; all of humanity would be contained in a single, fragile craft, undertaking an exodus with ironic parallels to the evacuation forced on the Qax so long ago.

Then the Qax would strike.

Paul considered. The Qax's enmity to humanity had endured for millions of years; it transcended hatred, even calculation, and had metamorphosed into a species imperative.

It was ironic that until his entrapment by the Qax Paul had imagined that the humans' greatest source of danger would be the rampant photino birds. Now he found it difficult to envisage how the little band of humans could run the gauntlet of this ancient enemy and survive their passage to the Ring.

Time wore away on its various scales. The Qax did not molest him, content for now to absorb information. Paul set up an array of sub-personalities to debate options for the survival of the humans.

At length he made a decision.

She missed Damen.

Surely he would enjoy slipping his hands into these mittens and driving the ship as if it were some great bird. She imagined him here in the Eight Rooms sitting with the rest, semi-naked and glistening with sweat, gaining rolls of healthy fat--

But the image crumbled. In Damen's heart, she reflected sadly, there would never have been the will to confront the strangeness of the ship, the Friend. And now she had lost him forever. He, stubborn, would never travel to the Eight Rooms, and her companions would never agree to a return journey...

Then she had an idea.

The ship rested in its place against the Eighth Room.

Erwal sat at her table and slipped her hands once more into the mittens; and she walked the point of view of the panel over her head and out through the Eight Rooms.

Belatedly she realized that the mitten controls were coarse, intended to take the window-eyes through miles at a time; soon her fingers and thumbs ached with the strain of keeping the limited motion smooth. With practice, though, she was soon able to move the focus over the heads of the oblivious villagers and out through the door of the first Room.

She flinched as the point of view passed through the unopened door.

She hovered over a plain of dirty snow. She found herself shivering -- but, of course, the panel brought her only the image of the ice land, not the sound of the wind, the bite of frost. With a twist of her thumbs she rotated her view so that she was looking back at the first Room. It hovered in the air, complete and plain, giving no indication of the wonders which lay beyond it.

"It's as if we were out there looking at it."

Erwal turned. Sura stood behind her chair, hands clasped meekly behind her back. "Why are you looking at

all that snow and ice?" the girl asked. "It makes me feel cold."

Erwal reflected how young Sura looked; it was as if the warm safety of the Rooms, the ship, had restored to her the youth rubbed away by the cold of the village. "...I'm not sure. I suppose I miss it."

Muscles in the girl's cheeks stood out like ropes. "Well, I don't."

"I want to... ah, walk the window back to the village. But I'm not sure if I can find it again."

"I'll help you." Sura sat on the floor, folding her legs beneath her. "You go south from the Rooms. Look for the tree where we found Teal's marker."

"South... yes."

The focus moved at little more than walking pace over the icescape. Erwal and Sura peered at the screen searching for pointers in the blank terrain. Gradually Erwal learned to sweep the focus through miles in a few minutes, stopping occasionally at some vantage point to gain fresh bearings.

It was so easy, compared to the deadly pain of the real trip, that Erwal felt ashamed.

As the hours wore by other villagers observed what she was doing. Slowly a circle of them built up; some of them offered bits of advice while others preferred to keep their distance, simply watching. Erwal made no comment.

Eventually they found the treestump to which still clung a flap of cow skin. Sura placed her hand on Erwal's back; the fingers pinched painfully at Erwal's muscles. The villagers stared at the rag, subdued and silent.

After another day of surrogate traveling, with Erwal's hands aching, the panel-eyes came at last to the village.

Snow lay in drifts against the crushed teepees. No smoke rose. Mummy-cows lay in great mounds of snow, exposed flesh frozen to their bones.

Erwal snatched the viewpoint into the air, so that it was as if they were looking down at the ruins of a toy village.

Humanity's last enemy, winter, had won. Somewhere Sand lowed softly. Arke gently laid his palm on Erwal's head. Erwal probed at her emotions, seeking grief. Then she turned the panels opaque and drew her hands from the gloves.

The villagers were quiet, but after a few hours they returned to their lazy, peaceful shipboard life. Erwal found herself relaxing with the rest, and soon it was as if the images on the panels had been no more than a feverish dream...

Later, though, Erwal climbed alone through the Rooms to the first and pushed open the door. The cold air sliced into her lungs. Barefoot, dressed only in a tunic, she staggered into the knee-deep snow. Suddenly her grief was as tangible as the frozen ground beneath her feet. She gave herself to it and tears froze to her eyes and cheeks.

His scheme, his sub-units concurred, was as unlikely and improbable as any of the wild ventures undertaken by humans in the past. Its only merit was that it was better than allowing the Qax simply to crush the Xeelee ship.

His plan hinged on the fact that the humans faced two dangers: from the Qax and from the dark matter photino birds. The photino birds were vastly more powerful, but the Qax, with their unswervable intent, represented the greater immediate danger. Clearly the humans could not fight through either -- let alone both -- of these great powers to the goal of the Ring.

Well, then: the foes must be diverted.

Paul withdrew subtly from the Jovian world. He was aware that the Qax were watching him, but they did not try to interfere. He diffused the foci of his awareness and spread himself as thinly as possible along the quantum world lines. He organized the data comprising his



consciousness into a particular configuration, an empty, interrogative form.

Like a child seeking its mother he called the antiXeelee.

The antiXeelee had left the Universe at the launch of the Sugar Lump seed fleet. It had traveled back in time with its fleet, and -- simultaneously, and without paradox -- had dissolved into countless melting fragments of awareness. So the antiXeelee had gone... but Paul inhabited a quantum Universe in which nothing was ever final. With patience and watchfulness he maintained his call.

...Fragments of the antiXeelee replied. It was like an echo of a lost voice. A pale outline of the awareness of the antiXeelee was reconstructed in response to the demands of Paul, and again Paul was surrounded by its vast, passionless humor. He responded as best he could, endeavoring to strengthen the presence of the antiXeelee.

He sensed confusion in the hierarchy of the Qax, but Paul ignored them.

At last the response he was waiting for came. Spectral ships miles wide coasted through the Jovian's system.

The presence of the antiXeelee might signify to an alert observer that the Xeelee had returned to the cosmos, and -- as Paul had hoped -- the Xeelee nemesis, the dark matter photino birds, had come to find out what was going on.

Paul, straining, maintained the illusion/substance of the antiXeelee. At length the dark matter ships departed with, as Paul intended, a new purpose.

He relaxed and the antiXeelee outline subsided into the quantum hiss of the Universe.

The photino birds, convinced that the Xeelee might reinvade the Universe from which they had been driven, would abandon their projects and focus their energies on Bolder's Ring. They'd already set in place long-term mechanisms to destroy the Ring. But now the closure of that gateway had to be accelerated; the Ring must be closed before the Xeelee could use it to return.

...But if the Ring were closed the Qax would be trapped in a dying Universe, their dream of species immortality threatened. So, Paul calculated, the Qax would have to get to the Ring and stop the photino birds from destroying it. With a sense of amusement and fascination he watched the urgent debate of the Qax, data and propositions chattering across all the scales of space and time.

Forgotten, Paul allowed himself to exult. His scheme seemed to be working. If so he had not only afforded the remnants of humanity a chance: he had also changed the species imperatives of two great races.

He slid along the quantum net to his little band of humans.

Across the Universe vast forces began to converge on Bolder's Ring.

The Friend had returned. And the visions were so vivid she could hardly see.

...A place, unimaginably far away, where a Ring, sparkling and perfect, turned in space; a place where all the starlight was blue...

"Erwal? Are you all right?"

The fantastic pictures overlaid Sura's concerned face. Erwal rubbed the leathery skin around her eyes. Her sight clouded by other worlds, she clung to comforting fragments of reality: the sound of children's laughter, the sweet, milky scent of the mummy-cow. "I'm all right. Just a little dizzy, perhaps. I need to sit down..." With Sura's help she touched the warm, soft wall of the Room and, as if blind, worked her way to the floor and sat down.

...She soared over the vast, tangled Ring; her fingers trembled in the glove-controls...

She opened her eyes, shuddering.

Sura sat down beside her, still holding her hand. "It isn't just dizziness, is it?"

"...No." Erwal hesitated, longing to unburden herself. "Sura, I think we have to travel again. Go away from here."

Sura's grip tightened. "Brave the snow again? But--"

"No, you don't understand. In the ship. We have to travel in the ship."

"But where to?"

Erwal said nothing.

Sura said slowly, "Why do we have to go? I don't understand. How do you know all this? You're frightening me, Erwal."

"I'm sorry. I don't mean to. But I don't think I can explain. And..." And I'm frightened, too, she told herself. Not by the mysterious visions -- not anymore -- but by what they represented: a journey the likes of which no human had undertaken for a million years.

She didn't want to go. She wanted to stay here, in the warmth; she didn't want to face anymore danger and uncertainty. But the visions were powerful, much more so than before; it was as if the Friend were screaming into her face.

The Friend was frightened, she realized suddenly. And what could such a godlike creature be fearful about?

"We have to go," she said. She could feel Sura's hand grow stiff in hers. "You think I'm mad, don't you?" she asked gently.

"No, Erwal, but--"

"For now you'll have to trust me," Erwal said, keeping her voice as steady as she could. "Look, I've been right in the past. About the healing panels, and the food boxes. Haven't I?"

"...Yes."

"Well, now I'll be right again. We're in great danger. And to escape it we have to go to this other place." The visions cleared briefly -- miraculously -- and she was afforded a glimpse of Sura's wide eyes. "Sura, we'll be safe in the ship. We'll be warm and dry."

Slowly the girl nodded. "It can't be worse than the snow."

"That's right," Erwal said firmly. "Not as bad as the snow."

After a time Sura said: "What do you want me to do?"

It took the fattened, slow-moving villagers several days to organize themselves to Erwal's satisfaction.

Not everyone was willing to come, of course. Some decided to stay behind in the Eight Rooms, unwilling to gamble their security and warmth on Erwal's unexplained visions. The ship's food lockers would provision the travelers, and so Sand, the last mummy-cow in the world, was left behind to sustain the rest.

Erwal found it hard to blame the stay-behinds.

After so much hardship together the leave-taking was protracted and difficult, each villager sensing that there would never be a reunion. Erwal stroked the stubby hairs at the root of the mummy-cow's trunk; huge, absurd tears leaked from Sand's eyes.

At last it was over. The stay-behinds gathered in the Eighth Room. Arke was among them, and Erwal studied his round face, trying to imagine his future, locked up in these tiny Rooms. The children would grow, of course, and perhaps have children of their own -- why not? The bones of the dead would be laid in the snow outside, in rising heaps, and time would pass without incident; until finally the faithful mummy-cow would succumb to age, and the last people would die with her.

Abruptly Erwal felt restless, anxious to depart. Surely the human story was not meant to end like this, with the last of them hiding away in a box.

Arke pushed at the door control; the crystal panel slid across the face of the Eighth Room. The ship was cast free. Erwal's group gathered in a nervous huddle at the center of the ship's chamber. Erwal, self-conscious, walked across

the cabin to her familiar seat and slipped her hands once more into the magical gloves.

The ship unfurled its night-dark wings. She closed her eyes, feeling a surge of exhilaration. The Friend was with her: the barrage of visions had mercifully ceased, but she could sense his presence, as if he were standing behind her, grave and quiet.

It was time.

She summoned up a memory of the shining Ring--

-- the ship quivered--

-- and abruptly the Friend flooded her memory-picture with color and detail; determination flowed through her into the gloves and--

-- jump--

It was like a stumble, a fall. There were screams behind her. She looked up, startled, at the panel-windows: the pale lines of the Eighth Room had vanished, to be replaced by a ball of fire, vast, red, brooding; flames as big as worlds licked out at the ship and--

-- jump--

-- and another jolt and the fire was replaced by nothing, nothing at all, and--

-- jump--

-- there was a tilted disc of color; she saw reds and browns and golds and it was so lovely it made her gasp but--

-

-- jump--

-- it was gone and--

-- jump -- jump -- jumpjumpjump...

Images battered against the screens like gaudy snowflakes.

She switched off the screens. The panels emptied and turned silver-gray, and there was a sigh of relief from her companions. But the jumps continued; she could feel them as a soft flutter in her stomach.

Cautiously she withdrew her hands from the gloves, stared at the mittens as if they had betrayed her. She had thought she understood the ship; now she had been humbled, a child at the feet of the adults. She sensed the Friend's strained reassurance but took little comfort. *I hope you know what you're doing*, she thought savagely. *Maybe we're more stupid than you know. Or... more fragile.*

In their borrowed Xeelee ship the little group of humans hurtled across the hostile Universe.

Paul sensed the bafflement of the woman, and anguish infiltrated his partial personalities. He had known that the initiation of the Xeelee hyperdrive would terrify the humans, but there was little he could do to protect them.

There was no time for this introspection. He must seek the Ring himself.

Paul's focus of attention swept restlessly around the Solar System's abandoned periphery. He found shipyards, weapons shops, blood-stained hospitals, the foundations of massive industrial complexes. Warships and fortresses, some as large as moons, circled the distant Sun.

Once two objects have been in contact they are forever linked by a thread of quantum wave functions. Once this had formed the basis of humanity's inseparability communications net. Now the prowling Paul found tenuous quantum functions arcing from the warships to forgotten battlefields scattered across the Universe. Paul knew that the humans had attacked the site of the Ring, at least once; so among these haunted wrecks there must be relics of those great assaults, and a quantum link for him to follow.

At last he found it.

The Spline ship was a mile-wide corpse, its spherical form distorted by a single, vast wound a hundred yards across. Within the wound, organs and dried blood were still visible. Paul imagined the agony of the creature as it had

returned from the battlefield, its guts open to the pain of hyperspace...

But this corpse-ship was embedded in a web of quantum functions which spun all the way to Bolder's Ring; these sunken Spline eyes, hardened now, had once gazed upon the Ring itself.

Paul wrapped himself around a pencil of quantum functions. Absorbing them into his awareness was like being stretched, expanded, made unimaginably diffuse.

Cautiously at first, then with increasing confidence, he began to adjust the phases of the quantum threads, and the multiple foci of his awareness translated through spacetime.

Paul hauled himself along the quantum functions in search of Bolder's Ring.

It was as if he were sliding down a long, vast slope in spacetime. At first the slope was all but imperceptible, but soon its steepness was unmistakable.

The Ring was the most massive single structure in the Universe. It was like a boulder dropped into a pool: across a region hundreds of millions of light years wide its monstrous gravity well drew in galaxies as effortlessly as a lamp attracts moths. Now Paul was crossing the lip of that well, with the shining ruins of the Universe sliding alongside him. Eventually he saw how the fragile structures -- the filaments, loops and voids of galaxies which had emerged from the singularity itself -- were distorted, smashed, broken by the fall into this great flaw in space.

The galaxies -- all around the sky -- were tinged *blue*, he realized now. Blue shift.

He had come, at last, to the place all the galaxies were falling into.

The Ring was a hoop woven from a billion-light-year length of cosmic string. Paul's principal awareness focus was somewhere above the plane of the Ring. The near side

of the artifact formed a tangled, impenetrable fence, twisted exuberantly into arcs and cusps, with shards of galaxy images glittering through the morass of spacetime defects. And the far side of the object was visible as a pale, hard band, remote across the blue-shifted sky.

Paul could study the Ring as Jim Bolder never had. With relish he sent sub-personalities skating along the tangled quantum functions that reached deep into the Ring's stretched spacetime.

Cosmic strings were residual traces of the ultrahigh, symmetric vacuum of the primordial epoch -- an era in which the forces of physics had yet to "freeze out" of a unified superforce -- and the strings were now embedded in the "empty space" of the Universe, like residual lines of liquid water in solid ice. And the strings were superconducting; as they moved through the primordial magnetic fields, huge currents -- of a hundred billion billion amps or more -- were induced in the strings...

The strings writhed, like slow, interconnected snakes, across space. The strings were moving at close to lightspeed. They left behind them flat, glowing wakes -- planes towards which matter was attracted, at several miles a second.

Paul looked into the center of the Ring. There he found a singularity. It was hoop-shaped, a circular flaw in space: a rip, caused by the rotation of the immense mass of the Ring. The singularity was about three hundred light years across -- much smaller than the diameter of the Ring itself.

If the Ring were spinning more slowly, the Kerr metric would be quite well-behaved. The singularity would be cloaked in *two* event horizons -- one-way membranes into the center -- and, beyond them, by an ergosphere: a region in which gravitational drag would be so strong that *nothing* sublight could resist its current.



But the Ring *was* spinning... and too rapidly to permit the formation of an event horizon, or an ergosphere. And so, the singularity was *naked*.

Through the void at the heart of the Ring he could see blue-shifted starlight muddled, stirred. Here the wave functions were tangled, twisted, broken; here space was folded up like cheap cloth.

This distortion was the purpose of the Ring: this was the Kerr-metric Interface, a route to other universes -- the gateway through which the Xeelee had made their escape.

...Ghostly flocks slid through the tangled cosmic string net that made up the Ring.

Paul widened his perception to embrace the entire Ring. Everywhere the photino birds soared, silent and purposeful. Somehow the great artifact seemed helpless, and Paul felt an absurd impulse to hurl himself forward, to try to protect the glorious baryonic monument.

At length the photino birds appeared to come to a decision. A knot of birds, billions of them, formed around one section of the toroid -- perhaps some weak point -- and from all around the Ring more bird flocks flickered in short hyperdrive hops to join the growing throng. Soon only a few scouts were left near outlying parts of the Ring, and around the weak point there was a swarm of shadow birds so thick they obscured the Ring itself.

Cautiously Paul slid his awareness focus closer to the stricken region. The photino birds, he realized, were now passing into the structure of the cosmic string itself.

If cosmic string self-intersected it cut itself. A new subloop formed, budding off the old. And perhaps that subloop, too, would self-intersect, and split into still smaller loops... and so on.

Paul understood. It would be an exponential decay process, once started. And so the birds, concentrating their mass, deflected the passage of string loops, causing them

to self-intersect. Soon, threads -- fragments of string thousands of miles long -- drifted out of the structure, passing unimpeded through the ranks of birds.

Soon the ghost-gray birds were jostling in their eagerness to breach the threads; and, within minutes, a slice through the Ring -- extremely thin, no more than a light year wide -- began to turn a dull yellow.

The photino birds were cutting the Ring, Paul realized uneasily, and it didn't appear that it would take them very long. And his little band of humans was still hours away.

He swept over the plain of the Ring and studied the turbulent space at its center. Thanks to the activities of the photino birds the Kerr-metric zone was like a pond into which gravel was being thrown. Star images rippled, and the inter-universal surface was awash with a milky blue light. Already the access paths through the zone must be disrupted--

-- and a shock wave of gravitational radiation burst over him.

Rapidly he withdrew his attention foci from the Ring and rose to the roof of its star-walled chamber, so that it was as if he were an insect in some vast cathedral. Something monstrous had erupted into this region of space, mere light minutes away from him. He surveyed the space around the Ring, seeking the source of the gravitational radiation.

...It had burst out of hyperspace like a fist. At first Paul could make out nothing but a blaze of blue-shifted photons and gravitons. Then, gradually, he perceived its structure. It was a sphere a million miles wide. Fusion fires still burned within it, although its structure had clearly been badly damaged by its impact at near lightspeed with the debris in the Ring chamber: great gobbets of material showered from its surface, so that it left a trail like some impossible comet as it blazed, Paul saw, towards the throng of photino birds.

It looked like a ball of ice-cream thrown into a bank of live steam. But it was a star: a star that had been accelerated to near lightspeed and then launched through hyperspace. And it was aimed directly at the photino birds' center of operations.

This was a weapon of war. The Qax had arrived.

After that things began to happen fast.

For days the ship had hurtled on.

Erwal knew she had no real understanding of the distances she was traveling, but she could sense how far she was being separated from the place of her birth.

And she and her companions were utterly alone. Even the Friend had withdrawn once more.

From time to time she slid her hands into the gloves and felt the continuing surge of the marvelous ship. And occasionally -- when her companions were asleep -- she would open one of the panel-windows and stare gloomily at the bright spheres which battered against the panel like vast insects, or at the distant pools of muddy light which sailed more slowly by.

Inside the ship there was, of course, no pattern of day and night by which to measure time, but Erwal counted the sleep periods that passed during the journey. Soon after the fourteenth she became aware, through the subtle touch of the gloves, of a change in the ship's motion.

Hastily, still blinking sleep from her eyes, she opened a panel-window.

The barrage of stars was visibly slowing, and the motion of the distant pools of light was almost gone. Had they arrived, then? She peered at the screen.

A wall of starlight, muddled and blue-stained, blocked off the sky. She stared, awed.

Her companions stirred in their nests of rags on the floor. Hastily she shut off the panel and sat in her chair, wondering what to do now.

The Qax assault approached its climax.

The hijacked star was mere minutes away from impact with the workplace of the dark matter photino birds, and its hellish glow brought a million dancing highlights from Bolder's Ring. Now Qax-controlled Spline ships crackled out of hyperspace in the wake of the star, their fleshy hulls sparkling with weapons fire. Paul saw how the photino birds were responding; insubstantial flocks rose from the Ring material, like steam from wet earth, to face the Qax vanguard.

One photino bird flock got too close to the star. Paul watched raging gravitational radiation tear open the flock's structure. Within seconds the birds had dispersed.

...And, just at this crucial instant, a little clump of consciousness knots popped out of hyperspace, emerging just outside the clear space around the Ring.

The humans had arrived. Paul hurried to them.

Wings outspread, the Xeelee ship hurtled through a storm of light.

The panel-window showed blue stars, hundreds of them jammed together, some so close they were joined by umbilici of fire. The villagers stood and stared, transfixed. Children clung to the legs of their parents and cried softly.

"Turn it off!" Sura buried her face in her hands. "I can't bear to look at it; turn it off!"

Erwal gripped the gloves grimly. "I can't," she said.

The Friend was in her head again, his visions a clamor that left her unable to think.

Onwards, he said. She had to go onwards, deeper into this swarm of insect-stars, using all the skills she had learned to haul the ship through this barrage of stars. Tears leaked out of her eyes, but she dared not rest. Her world narrowed to the feel of the gloves on her stiffening hands, the gritty rain of stars in her eyes.

With a soundless explosion the ship erupted into clear space.

Erwal gasped, pulled her hands out of the gloves; the ship seemed to skid to a halt.

They were in an amphitheater of light. The far wall was a bank of stars, hard and blue; it curved into a floor and ceiling also made of blue-tinged starstuff. And at the center of the vast chamber was a jewel, a Ring that turned, huge and delicate. One point of the Ring was marred by smoke; red and blue light flickered in that cloud.

Erwal felt Sura touch the crown of her head. The girl's hand seemed to be trembling, and Erwal laid her own hand over Sura's -- then realized that the trembling was her own, that her whole body was shaking uncontrollably.

Sura asked, "Are you all right?"

"...I think so."

"Where are we?" Sura pointed. "What's that? It's beautiful. Do you think it's some kind of building? Why, it must be miles wide."

But Erwal barely heard. Once more the Friend clamored in her thoughts, pressing, demanding; she longed to shut him out--

Without hesitation she shoved her hands back into the gloves. The Xeelee ship plummeted into hyperspace.

The weapon-star burned through the ranks of photino birds towards the Ring. Vast as it was the star was lost against that great tangled carcass...

Until it hit.

The battered star collapsed as if made of smoke. Sheets of hydrogen, some of it still burning at star-core temperatures, were dug out of the star's gut by writhing cosmic string. The star's mass was reduced from lightspeed to stationary in less than a minute; Paul watched huge shock waves race around the Ring's structure.

Now the Qax's Spline warships followed up the starstrike; cherry-red beams lanced from their weapon pits, and Paul recalled the Xeelee gravity-wave starbreaker cannons observed by Jim Bolder. Photino birds imploded around the beams, flocks of them turning into transient columns of smoke that shone with exotic radiations and then dispersed.

For a brief, exhilarating moment, Paul speculated on the possibility of a Qax victory, a defeat for the photino birds after this single, astonishing blitzkrieg; and he felt an unexpected surge of baryonic chauvinism.

Soundlessly he cheered on the Qax.

But, within thirty minutes, the debris of the starstrike was cooling and dispersing. The photino bird flocks began to regroup, gliding unimpeded through the glowing wreckage of the star. Grimly the Qax fought on; but now, from all around the Ring, photino birds were flicking through hyperspace to join the battle, and soon the marauding Qax were surrounded. The Spline armada, with foe in all directions, became a brief, short-blossoming flower of cherry-red light.

Soon the end was beyond question. Ghostly photino birds penetrated the Spline fleet and overlaid the battered Qax ships, and the Spline, their effective masses increased enormously, began to implode, to melt inwards one by one.

Perhaps if the Qax had taken more time, Paul mused; perhaps if they had organized a barrage of the starstrikes...

Perhaps, perhaps.

Soon it was evident that the assault had been no more than a temporary inconvenience for the photino birds, and the shadowy flocks were swooping once more into the Ring's crumbling threads.

Dropping out of hyperspace was like falling through ice.

The panel-window filled with light, but Erwal, disoriented, could make no sense of the image: of the

threads of crystal-blue light that crossed the picture, of the sea of milky, muddled stars below her. Were those threads the Ring? Then they must be very close to it, poised over its very center. And what was the meaning of the crushed, twisted starlight below?

The Friend returned, screaming visions at her. She cried out, but she grasped the gloves.

Night-dark Xeelee wings stretched across space for the last time. Ignored by the warring fleets the ship dived towards the Kerr-metric Interface.

As Erwal entered the sea of light there was a moment of farewell, an instant of almost unbearable pain... and then the Friend was gone.

She dropped into strangeness.

The ghost-gray photino birds slid through the Ring's pale flesh and its bruiselike discoloration spread.

Paul, somber, reflected that the destruction of the Ring had in the end provided the key racial goal for the human race. But now that the end was close the last human -- Paul -- felt nothing but a cultured sadness, an aesthetic pain at the loss of such power and beauty.

The surviving Qax, too, were, at last, no more than impotent observers, ignored by the photino birds.

After about half a year the photino birds withdrew. The fruit of their labor was a slice through the Ring perhaps a light year thick. Around this darkling slice the substance of the Ring was crumbling, turning to sparkling threads that drifted away from the structure.

The Kerr-metric Interface wavered, dissolved; and the Universe was sealed.

Paul moved his attention foci closer to the gap. The broken threads of cosmic string shriveled from the wound, so that the gap in the Ring widened at near lightspeed.

Photino birds swooped around the wound as if in a huge triumphant dance.

The vast structure had no mechanism to recover from such a wound. Now there was only its long, slow death to play out; and the photino birds, evidently incurious, began to depart, returning their attention to their own mysterious projects.

Like sea waves from the wreck of some immense ship gravity radiation surged out of the Ring's gravitational well, and at last the vast pit in spacetime began to close.

The observers -- the Qax, the last photino bird flocks -- began to leave the scene. Paul grasped his quantum threads and slipped into the gathering darkness.

The Xeelee ship emerged from the Kerr-metric Interface. It furled its wings, slid to a halt, and sent its sensors probing into the new Universe.

Erwal stared at a screen that had become suddenly a blank pane of silver, reflecting only her own tired face.

Sura asked, "What does it mean?"

Erwal frowned. "I don't know." She tried to move the focus of the screen, but there was no response. And the gloves around her hands were like dead things, inert.

The ship no longer responded to her touch. She withdrew her hands.

"I don't understand," Sura said. "Did we pass through the Ring? What should we do?"

"How could I know?" Erwal snapped. "We wait, I suppose."

Sura stepped away, uncertain.

After some hours, Erwal climbed out of her chair and stretched painfully.

Trying to overcome her enormous sense of anticlimax she established a routine. After each of the next few sleeps she crossed to the control table and slipped her hands into the gloves. But the ship remained inert, sealed off.

Gradually her routine broke down.



She was tired, and she had had enough mystery. She tried to settle into life inside this odd ship-village and forget the strangeness outside.

The function of the Xeelee ship was to optimize the chances of survival of its human occupants.

It studied the purposeless emptiness stretching around it and considered how this might be achieved.

Gas clouds, dark and cooling, reached to the limits of this expanding Universe. There were no stars. There was no evidence of intelligence, or life.

The ratio of helium to hydrogen here was about twenty-five percent. This, and various other cosmological relics, told the Xeelee ship that this Universe had emerged from its singularity in a broadly similar fashion to that of the Universe of its origin, with comparable ratios between the fundamental forces.

This, of course, was good.

The semisentient ship was capable of independent speculation. Perhaps some property of the Ring had guided them to an inhabitable environment, the ship wondered.

It did not spend much processing time on such theorizing. After all, speculation was not its primary function; and even if it were, there was no one to report back to.

So the Universe was broadly similar to that once shared by humans and Xeelee. With one important difference.

It was much younger.

Less than a billion years had passed since the singularity here. No stars yet burned. There was virtually no iron, no carbon, no silicon -- no oxygen. Save for the helium and a few traces of more complex elements which had emerged from the singularity, there was only hydrogen. All the heavy elements would become abundant much later, when true stars began to shine and complex fusion processes in their cores got underway.

There were no Earths to land the humans on, no air for them to breathe, no metals for them to dig.

The ship unfurled its night-dark wings and dived into the hydrogen clouds. Cherry-red starbreaker beams blasted ahead of the ship; the gravity waves lanced through convection cells billions of miles wide, and a cylinder of roiling hydrogen-helium gathered. Within the cylinder temperatures rose by millions of degrees and complex fusion chains, comparable to those in the cores of the stars yet to form, were initiated.

A cascade of heavy elements emerged from the fires, and at last even a few atoms of iron were formed.

For three months the Xeelee ship patrolled the length of its creation; it passed its beautiful wings through the star-core cylinder, filtering out the heavy elements.

At last the Xeelee ship was ready to construct an Earth.

The heart of it was a core of iron seven thousand miles wide. Leaving the core at stellar-surface temperatures the ship now laid down a mantle of silicate rocks, constructed from the mineral banks it had built up, and overlaid the whole with a thin crust of oxygen and silicon. Next -- compressing billions of years of planetary evolution into weeks -- it deposited lodes of iron, bronze, tin, methane at suitably accessible points. There was even uranium. Then riverbeds, ocean floors, fjords were gouged out by the flickering of a cherry-red beam.

The process was creative; the ship almost enjoyed it.

After six months the bones of the planet were laid down. The ship landed at various points on the surface and, by firing refrigerating particle beams into the glowing sky, rapidly cooled the crust through thousands of degrees.

Next, ice asteroids were smashed into the bare surface, as were lodes of frozen oxygen and nitrogen. The ice melted and flowed into the waiting sea beds; gases hissed into a cloak about the planet.

All this took two more months; but at last the ship's night-dark wings cruised over clear oceans, through crisp blue oxygen.

The first clouds formed. Rain fell.

Next it was time to establish an ecosystem.

The ship had never visited Earth, or even the interior of the box-world its Xeelee designers had built for the humans. But it knew the general principles.

The ship's clay was the genetic material of its human occupants, and their various parasites and symbiotes. Tiny laboratories embedded in the ship's hull labored for many days.

The first priority was an oxygenating flora. The ship chose melanin, the tanning agent stored in the humans' melanocyte cells, to serve as the basis for a photosynthetic process. That, combined with extrapolations of the humans' intestinal flora, proved sufficient.

Rainforests exploded across the new continents, oceans of banyanlike trees force-grown by the ship. And a kind of plankton spread like a brown stain through the seas. Flows of energy and matter were initiated through the new biosphere, with life, climate and geology combining in a single grand organism, turning the infant planet into an autonomous, self-regulating life-support mechanism with a life span of millions of years.

Now: animals to populate the land and seas; to serve as food for the people? Human genetic material, the ship found, was a remarkably flexible substance; the adjustment of a mere few percent of the DNA strands gave astonishing scope for design.

This was another creative phase. The ship lingered over it, taking perhaps six months.

At last the various feedback cycles were established; the ecosystem, powered by sunlight, was established and self-sustaining.

The ship hovered over its creation, considering.

The world's sun was artificial, a fusion reactor, a miniature star. It blazed down, hot and red, over its unlikely new satellite. The star would last mere millions of years, but the ship decided that should be enough time for the humans to work out what to do next for themselves.

The wings of the Xeelee ship curved one last time over the new world.

It was done. It was good.

Without ceremony the ship settled to the ground, threw open its ports, and deactivated.

Enval arose from sleep, aroused by the soft scent of grass. She rose stiffly, rubbed the sleep from her eyes, and made her way over sleeping bodies past the open port to the control table--

*The open port?*

This port had not opened for a year and a half... Now it led to a gentle ramp. The ramp lay in light, and it nestled against soft earth.

Trembling, Erwal walked down the ramp and into light which warmed her neck. She paused at the ramp's edge, uncertain. Then, deliberately, she pressed her bare feet into the ground. The grass was cool and a little damp, as if dew-sprinkled -- and it was a deep, dark brown. A breeze, strange on her skin after months of ship's air, brought goosebumps to her bare arms.

She was standing on a grass-covered slope. The sun above was a pinkish red; beyond the sky, great billowing clouds were illuminated. The light brought out rich autumnal tones in the grass's dominant brown. The ship was a slim black cylinder, its wings folded away; it rested on the grass, incongruous.

The slope fell away to a river which slid, gurgling, between tree-lined banks. The leaves of the trees were brown too, a pale russet color; but they flickered convincingly in the breeze. (What was that she saw in the

branches of the trees? -- The little creature, about a foot long, returned her gaze with startlingly human eyes, and scurried out of sight to the top of a tree.) She looked along the river. As far upstream as she could see there were no ice-floes. In the distance gray mountains shouldered above the plain; snow touched their peaks. And downstream of the river she made out a line of light, right on the horizon. A sea?

Something came flickering through the sky, out of the Sun: a bird, no larger than her fist, scooting over the grass at about head-height. She reached up towards it, impulsively; the bird swiveled its tiny (human!) head towards her, opened its mouth in fright, revealing rows of jewel-like teeth, and veered away, rustling into the distance.

Sura came climbing up from the river. She was singing quietly. When she saw Erwal she smiled, her nose and forehead pink. "Erwal, where are we?"

Erwal laughed. "Wherever it is, it seems... agreeable."

Now more villagers came stumbling from the ship, open-mouthed; they seemed to expand as they sucked in the rich air. The children instantly ran off down the slope.

Erwal turned back to Sura. "What do you think we should do?"

The girl shrugged. "Get some teepees built, I suppose. Before the snows come."

Erwal nodded. "But maybe the snows won't be so bad here."

"No. Maybe not."

Arm in arm the two women walked down to the river.

## **C.A.D. 500,000,000**

Time passed.

After a certain point measurement of time became meaningless. For Paul this point arrived when there was no hydrogen left to burn anywhere, and the last star flickered and died.

Already the Universe was a hundred times its age when the Xeelee left.

Somberly Paul watched the dimmed galaxies subside like the chests of old men.

At last there was little free baryonic matter outside the vast black holes which gathered in the cores of galaxies. Then, as the long night of the cosmos deepened, even protons collapsed, and the remaining star-corpses began to evaporate.

Paul wearied of puzzling over the huge, slow projects of the photino birds. He sought out what had once been a neutron star. The carbon-coated sphere floating between the huge black holes was so dense that proton decay was actually warming it, keeping it a few degrees above the near-absolute zero of its surroundings; Paul, as if seeking comfort, clustered his attention foci close to this shadow of baryonic glory.

After some time he became aware that he was not alone: the last of the Qax had come sliding through the interstices of space and now hovered with him over the frigid surface of the star.

Human and Qax, huddled around the chill proton star, did not attempt to communicate. There was nothing more to say.

The river of time flowed, unmarked, towards the endless seas of timelike infinity.

# Epilogue

## EVE

*Eve was receding from me. I saw her face, as if it was turned up towards me, and I was rising, away from her.*

*The walls, the apartment, had disappeared. There was only Eve's face, and darkness.*

*"You must remember what you have seen, Jack. You must understand. You can see now why the Ghosts' project must go ahead. Can't you? Can't you, Jack?"*

*I shouted at her: "Tell me who you are, damn you. Tell me how you know all this, the future. Tell me!"*

*But my voice was a whisper, an insect-rustle; and she didn't reply.*

*Her face faded, as if a light had been turned off. And the Galaxy came out, crystallizing above me like a gaudy frost.*

*A Ghost hovered before me, concern sending ripples across its skin. "Jack Raoul. Can you hear me?"*

*I looked down. My hands were chrome, shimmering, returning complex highlights from the Galaxy's glow. "Oh, Lethe. I'm back."*

*"Jack Raoul? You have been unresponsive to stimuli for some time--"*

*I wanted to punch a hole in the Ambassador's complacent hide, and then retreat into the safe warmth of my own metal stomach. "What have you done to me? What right have you -- what right..."*

*Slowly, I became aware that all around me the Ghosts were rising, clustering around their skeletal ships, and sailing away from the deformed moon.*

*I tried to think beyond my own concerns. "Ambassador. What's going on?"*

*"Jack Raoul, it seems you have, after all, achieved your purpose. You have come here to observe our experiment. Now, you are ready to witness its climax, its magnificent conclusion." I heard pride in those thin translated tones, saw an insufferable arrogance about the Ambassador's sleek shimmer.*

*I looked down at the moon. The intrasystem pods were active, working symmetrically around its battered surface, holding the moon in place.*

*And, down through the splayed-opened hearts of ancient craters, the quagma pods were descending towards the core.*

*With the Ambassador, I fell away from the Galaxy, descending beneath the moon.*

*The sky was empty of stars. The Galaxy was a mottled, glowing ceiling above us, and beneath my feet there was only the distant, etiolated smudge of remote galaxies.*

*I looked at it all with new eyes. Those shining stars were already infected by the photino birds. Even the most remote galaxy I saw would be affected by the final conflict, between the birds and the doomed Xeelee.*

*Behind the bright light of the Universe, I had glimpsed the skulllike dismalness of the end of time.*

*The Ghosts and their ships had gathered into a rough sphere, a couple of thousand miles from the moon's surface; the moon hovered above me, a fat, battered orange, made three-dimensional by the subtle shading of Galaxy-core light.*

*The Sink Ambassador said, "The climax is approaching." I sensed excitement in the complex patterns which shivered across its surface.*

*"Tell me how you can make a star of dark matter."*



*"Jack Raoul, there are ways to generate compact, self-gravitating solitonlike equilibrium states of bosonic fields. Here we are seeking an oscillating solution, known as an oscillation, which--"*

*"Lethe," I said. "I wish Eve was here."*

*"Your wife."*

*"The real Eve. She was the only one who could make sense of all this stuff for me."*

*The Ghost said nothing.*

*"Keep talking," I said.*

*The Ambassador, tried again, in language only slightly less technical, and my internal stores began to feed back trickles of interpretation to me, integrating what the Ghost was saying with the best human models.*

*Gradually, I began to figure out what the Ghosts were trying to do.*

*Dark matter can't form stars, because it can't cool down fast enough.*

*When a clump of baryonic gas -- normal matter -- collapses under gravity, electromagnetic radiation carries away much of the heat produced. It is as if the radiation cools the gas cloud. The residual heat left in the cloud eventually balances the gravitational attraction, and equilibrium is found: a star has formed, a compact, stable body, with internal radiation pressure balancing out the tendency to collapse through gravitation.*

*But dark matter doesn't produce electromagnetic radiation. And without the cooling effect of radiation, a dark matter cloud, collapsing under gravity, traps much more of its heat of contraction. So large, diffuse clouds are the equilibrium form for dark matter.*

*"But," I said drily, "you've found a way around that." The Sink Ambassador spun complacently. "We are going to use*

*another way to cool a clump of dark matter: gravitational cooling."*

*I imagined a swarm of photinos, orbiting each other. The swarm could eject its own faster-moving members, sling-shotting them out like miniature spacecraft around shadowy planets. Because kinetic energy was equivalent to heat, the clump left behind would be cooler, more compact.*

*"The mechanism is similar to what you know as the Lynden-Bell analysis of the Jeans instability," the Ghost said. "The mechanism whereby a star cluster can settle to a compact, stable equilibrium by collisionless relaxation: ejecting its own faster-moving components to an outer halo--"*

*"Enough. So you're going to use gravitational cooling to form a dark matter star, right here."*

*"The quagma pods will impact in the core of the moon, in a complex manner. They will be induced to decay and coalesce; their stores of superforce energy will be released in shaped pulses. The resulting gravitational waveforms will initiate the process. A photino cloud of approximately the mass of a small planet will begin to coalesce. Some thirteen percent of the cloud's mass will be ejected during the violent relaxation process. The final soliton star will be just a few feet across, at the heart of this moon. A complex massive Klein-Gordon scalar field will be produced, with no self-interaction save through gravity, which..."*

*I tuned him out. I fed all this into my Notebooks.*

*"Why here?"*

*The Ghost spun, bobbing in space. "There is much dark matter, here in the galactic halo. And few Xeelee."*

*"And few humans, right?"*

*"I would be interested to know of the source of your information on the project, which--"*

*"It's going to take some close control," I said. "The crucial events will last just microseconds: that complex sequence of quagma collisions in the core... Ambassador, you must have one giant AI controller built into that moon."*

*It said nothing to that, and a grain of suspicion lodged in my mind. But I had other issues to pursue.*

*"Tell me why you're doing this, Sink Ambassador. If you make a soliton star -- so what? What will you have achieved?"*

*It rolled, as if it was turning to face me.*

*"You know as much as we do, now, about the fundamental truths of the Universe," it said. "The secret history of the cosmos: the epochal conflict between light and dark matter, whose effects we have only begun to discern."*

*"To sustain their existence, the creatures of photino matter need stable baryonic star cores. And therefore they are accelerating the evolution of the stars." It rolled in space. "Even now," the Ambassador said, "photino creatures are clustered in the hearts of those hundred billion stars, choking them. Even the original star of mankind, called Sol."*

*"But they face resistance."*

*"Yes. From the baryonic life forms whose habitats they are destroying. But even the Xeelee, immeasurably stronger than my race or yours, will be defeated."*

*I knew that was true, from the glimpses Eve had vouchsafed me.*

*"And so--"*

*"And so," the Ambassador said, "we are striving to generate another option. A better way." It wheeled over the shaped moon. "Raoul, the quagma pods are merging in the moon's core. It begins..."*

*I started to understand. "You think that if you can show the photino birds how to build star-sized objects of dark matter -- without using the cores of baryonic stars -- they will stop destroying the stars."*

*"That is the goal. The dream, if you will."*

*"And the great Xeelee war can stop, and we'll all coexist; we'll live together, photino birds and Xeelee and humans and Ghosts, like one huge family." I felt like laughing at it. "Lethe, Ambassador. At least you Ghosts can't be faulted for thinking big."*

*"Now," it said, "you must understand why your opposition to this project must be withdrawn. On the success of this experiment, the future of the cosmos could hinge."*

*I looked up at the engineered moon. There was a sense of mistiness about it, as if a great liquid lens had gathered over that pulverized surface; the light of the Galaxy was refracted, shimmering and softened. I stared into the dark matter mist, hunting for structure.*

*"It is working," the Ghost said. "The photinos are coalescing. Soon, the equilibrium oscillations will be induced..."*

*A trickle of data started whispering in my head. Interpolations and feedback from my datastores, Eve's Notebooks. Shadowy Virtuals glimmered around me: schematics of the moon, the photino star the Ghosts were building, little charts of growth rates, density-time fluctuations.*

*There was something odd. The projections of the soliton star's formation -- based on human mathematics -- didn't match up with what the Ghost had told me...*

*But I was still preoccupied with my hardening suspicions. I thought about prophecy.*

*Humans had built Michael Poole's wormhole, and benefited from the fragments of data it had delivered: data from the ends of time. Perhaps the Ghosts, and other races, had achieved similar glimpses of the future.*

*But all such glimpses are fragmentary and incomplete.*

*Prophecy is possible using scientific laws, where sufficiently simple events are concerned: the eclipse of a sun, or the return of a long-period comet. And prophecy based in the more complex human arena has been used, after a fashion, for most of humanity's recorded history. My Notebooks told me about actuarial tables, devices for predicting death rates, that even predated human spaceflight. The more computing power is available, the more detailed a prophecy is possible.*

*To spin out a future vision as detailed and granular as the one I'd been vouchsafed by Eve must have required computing power an order of magnitude more powerful than anything available to humanity.*

*Or to the Ghosts.*

*All at once the Ghosts were rich in processing power.*

*Suddenly, I saw it.*

*"You let it out," I accused the Ambassador.*

*"Jack Raoul--"*

*"You let it out. The Planck Zero AI. You released it."*

*"It proved possible to accelerate the production of Hawking radiation, the natural evaporation of the black hole within which the AI was contained, which--"*

*"Lethe. That AI was insane. You Ghosts may have destroyed us all. Ambassador, I'm going to file a full report about this. I'm going to get this operation shut down, and have human monitors placed in every Ghost research establishment from now on."*

*"The AI is a powerful resource. Jack Raoul, we face cosmic obliteration. Even the Xeelee cannot shelter us.*

*Surely the risk was justified. And as to the project, it is too advanced for--"*

*I was aware of agitation among the flock of watching Ghosts. They started withdrawing further from the moon.*

*An internal warning started to sound in my head. The Notebooks had come up with something they didn't like. More Virtual schematics, primary-color projections, started filling up my vision.*

*The vents dug into the moon had started to glow, dull red. I saw molten rock bubble at the edge of one pit, its lip slumping into the cylindrical tunnel below. It was as if a fire burned in the moon's core; light poured out into space, illuminating the construction debris which clustered around the moon, and glimmering off the hides of the watching Ghosts, turning them to beads of fire.*

*In the moon's surrounding veil of dark matter mist, I saw shadowy shapes hurtle, agitated, birdlike.*

*...And Eve was beside me now. She was Ghost-transformed as I was, her long-boned face easily recognizable under the chrome.*

*She watched the metamorphosing moon, its fiery glow reflecting from her silvered eyes.*

*The Sink Ambassador twisted in alarm, its hide glowing red, chattering on many frequencies to its fellows.*

*"It isn't stable. The photino star. Is it, Eve?"*

*"No," she said dreamily, not taking her eyes off the moon. "The density of photinos is too high."*

*"Yes." That fit with what Eve's Notebooks were telling me. "The high density at the core is stimulating photino decay. The free Klein-Gordon field the Ghosts want to create is collapsing. Imploding--"*

*Abruptly the Ghosts fled, including the Sink Ambassador, abandoning us; I saw their receding ships, shining threads against the intergalactic darkness.*

*The surface of the moon was almost entirely molten now. It was subsiding, collapsing inwards.*

*"The Ghosts thought they were creating a home for the photino birds," I said. "But they were wrong. You knew that. They have made--"*

*"A bomb," she said. "A dark matter bomb."*

*"It's you, isn't it? The Planck Zero AI. Behind the mask of my wife--"*

*She pressed her face against my metallic chest.*

*My anger was gone. Only pity remained.*

*I embraced Eve, enfolding her within my arms. Her skin felt warm -- impossibly so -- human.*

*"But this will destroy you," I said. "Whatever it is that sustains you, is in that moon."*

*She turned to me, silver eyes empty, and smiled. I saw that she wore my ring on her finger.*

*The thing at the heart of the moon turned white, dimming the sickly glow of the Galaxy's core.*

*The moon blew apart.*

*Molten rock, quivering droplets of it, showered up past us, patterning against my skin. I closed my mechanical eyes and huddled with Eve, waiting for the rocky storm to pass.*

*Eve -- the Planck Zero AI -- wasn't destroyed. It proved possible to reconstruct some of it from the records and fragmented datastores left behind.*

*It was still sentient, but it was crippled. Its residual abilities were not much more than a human's.*

*I took it -- her -- home.*

*Now, we spend most of our time in a simulation of our old apartment, in a Virtual never-never-land.*

*I've tried to figure out why she did what she did.*

*Already mad with the desolating quantum loneliness of her birth, she'd been brought out of her black hole prison, and was presented with all the Ghosts' data on the future.*

*And, desperately intelligent, she suffered a vision of that future.*

*It was a vision of the destruction of all baryonic life, the desolate victory of the photino creatures: it was a rigid, logical and inescapable product of her own infinite intellect. It was a vision she couldn't bear.*

*So -- perhaps -- she subverted the Ghosts' hubristic experiments -- which do, incidentally, seem to have been genuinely aimed at a peaceful rapprochement with the photino birds. She allowed the Ghosts to make a dark matter bomb. Perhaps she was trying to open up a war with the photino birds, a new front, with a weapon that even the Xeelee had never considered.*

*Or perhaps she sought, simply, her own destruction. Release, from the terrible burden of infinite knowledge.*

*Even she doesn't know any longer.*

*As for myself, I can never know if Eve's bleak vision -- given to me in those startling, fragmented glimpses -- represents the true future history of our Universe. Perhaps it was just some mad fiction, concocted by her huge but damaged soul. Or perhaps it is only one strand of the truth; perhaps that gloomy future can, in the end, be averted.*

*Otherwise, in just a few million years, all humankind will be extinct in this Universe. And all our technology and intelligence and courage won't make a damn bit of difference in averting that fate.*

*If that's true, it's up to us to live as if it were not so.*

*I care for Eve, as best I can. We go on. What else is there for us to do?*



# The Xeelee Sequence-Timeline

## ***Singularity: Big Bang***

### ***Era: Primeval***

20 bya (billion years ago): Life forms in quagma broth. First contact between Xeelee and photino birds. Xeelee timeships begin modification of Xeelee evolutionary history.

10 bya: Construction of Ring begins. Birth of Sol.

5 bya: Assault on Ring by photino birds begins. Life on Earth emerges.

1 bya: First infestation of Sol by photino birds.

### ***Era: Expansion***

A.D. 3000 +: *Opening up of Solar System with GUT and wormhole technology. First human extra-Solar expansion begins.*

A.D. 3621: Birth of Michael Poole.

A.D. 3672: "The Sun-people"

A.D. 3698: "The Logic Pool"

*Timelike Infinity*

A.D. 3717: Launch of GUTship *Cauchy*.

A.D. 3825: "Gossamer"

A.D. 3829: Wormhole time-travel invasion by Occupation-Era Qax.

A.D. 3948: "Cilia-of-Gold"  
A.D. 3951: "Lieserl"  
A.D. 3953: Launch of GUTship *Great Northern*.

### ***Era: Squeem Occupation***

A.D. 4874: *Conquest of human planets by Squeem.*  
A.D. 4874: "Pilot"  
A.D. 4922: "The Xeelee Flower"  
A.D. 4925: Overthrow of Squeem.  
A.D. 5000 +: Second expansion begins.  
A.D. 5024: "More Than Time or Distance"  
A.D. 5066: "The Switch"

### ***Era: Qax Occupation***

A.D. 5088: *Conquest of human planets by Qax.*  
A.D. 5274: Return to System of GUTship *Cauchy*. Launch of backward time-travel invasion by Qax.  
A.D. 5406: "Blue Shift"  
A.D. 5407: Overthrow of Qax. Humans acquire Spline and starbreaker technology.  
A.D. 5500 +: Third expansion begins.  
A.D. 5611: "The Quagma Datum"  
A.D. 5653: "Planck Zero"  
A.D. 5664: "Eve"

### ***Era: Assimilation***

A.D. 10,000 +: *Humans dominant sub-Xeelee species. Rapid expansion and absorption of species and*

*technologies. Launch of Xeelee time-ships into deep past.*

A.D. 10515: "The Godel Sunflowers"

A.D. 21124: "Vacuum Diagrams"

### ***Era: The War to End Wars***

A.D. 100,000 +: *Humans assaults on Xeelee concentrations begin.*

A.D. 104,858: "Stowaway"

*Raft*

A.D. 168,349: Launch of the *Exaltation of the Integrality*.

A.D. 171,257: "The Tyranny of Heaven"

A.D. 193,474: "Hero"

*Flux*

A.D. 1,000,000: Final siege of Solar System by Xeelee.  
Defeat and imprisonment of man.

### ***Era: Flight***

A.D. 4,000,000 +: *Migration of Xeelee through Ring. Sol leaves Main Sequence.*

C.A.D. 4,000,000: "Secret History"

### ***Era: Photino Victory***

A.D. 4,101,214: "Shell"

A.D. 4,101,266: "The Eighth Room"

A.D. 4,101,284: "The Baryonic Lords" Destruction of Ring by photino birds.

A.D. 5,000,000 +: *Last humans return to Sol in GUTship  
Great Northern, and travel to Ring.*

*Ring*

A.D. 10,000,000 +: Virtual extinction of baryonic life.

<b><i>Singularity: Timelike Infinity</i></b>
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## Permissions

"The Sun-People" (under the title "The Sun-Person"), first published in *Interzone*, 1993.

"The Logic Pool," first published in *Isaac Asimov's Science Fiction Magazine*, 1994.

"Gossamer," first published in *SF Age*, 1995.

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"Lieserl," first published in *Interzone*, 1993.

"Pilot," revised from "Chiron," first published as a chapbook by Novacon, 1993.

"The Xeelee Flower," first published in *Interzone*, 1987.

"More Than Time or Distance," first published in *Opus*, 1988.

"The Switch," first published in *Edge*, 1990.

"Blue Shift," first published in *Writers Of The Future Vol V*, ed. Algis Budrys, 1989.

"The Quagma Datum," first published in *Interzone: the 4th Anthology*, ed. John Clute, David Pringle and Simon Ounsley, 1989.

"Planck Zero," first published in *Isaac Asimov's Science Fiction Magazine*, 1992.

"The Godel Sunflowers," first published in *Interzone*, 1992.

"Vacuum Diagrams," first published in *Interzone*, 1990.

"Stowaway," extracted and revised from *Raft*, HarperCollins, 1991.

"The Tyranny of Heaven," first published in *Dream*, 1990.

"Hero," first published in *Isaac Asimov's Science Fiction Magazine*, 1995.

"Shell," revised from "The Bark Spaceship," first published in *Dream*, 1987.

"The Eighth Room," first published in *Dream*, 1989.

"Secret History" and "The Baryonic Lords," revised from "The Baryonic Lords," first published in *Interzone*, 1991.

"Eve" (under the title "The Soliton Star"), first published in *Isaac Asimov's Science Fiction Magazine*, 1996.

## About the Author

Stephen Baxter is a trained engineer who took a first-class honors degree in mathematics at Cambridge University. He also has a doctorate in aeroengineering research from Southampton University, and for his degree worked with Rolls Royce Ltd. and at the Royal Aircraft Establishment, UK.

In his research, the author has visited NASA launch centers, viewed a shuttle launch, and interviewed NASA staff, including a mission controller and a space shuttle astronaut. He also researched histories of NASA and its missions, and technical material on spacecraft and boosters.

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**notes**

# Notes



**1**

See *Timelike Infinity*

**2**

See *Timelike Infinity*

**3**

*See Ring*

**4**

*See Ring*

**5**

*See Raft*

**6**

See *Flux*